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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

DECEMBER 19.

Lancashire Branch (Junior Section):—Short Paper competition.

What the Ironfoundries *Can* Do.

Foundrymen have a perennial grumble on the subject of the impossible patterns and specifications imposed upon them by the engineering fraternity, yet they meekly accept week after week jobs which they know will bring discredit upon the whole industry. They realise that if they question too strongly a customer's design or specification they will lose the order to some other concern which will placidly accept the conditions on the off-chance that other orders from the same source will be profitable. It is perfectly obvious that engineers should be taught that they must adhere to the principles of good casting practice, and, moreover, the present time is very opportune to teach them, as the engineer is beginning to realise that cast iron has potentialities of which he was but little cognisant; that high tensile strength is not the sole requisite in engineering materials; that wear, rigidity, heat and corrosion resistance are assuming an ever increasing importance, and that the foundry industry has a castings technique. Still, the engineer has a right to know what the foundries can do, not merely as individual entities, but as an industry, and the best means at the disposal of the industry are its two scientific societies, the Institute of British Foundrymen and the Cast Iron Research Association. Just recently they have decided to collaborate mainly for this very purpose. It is intended that reports will be produced which will show what the foundries can do. The Institute, through its nation-wide organisation, is in an excellent position to enunciate manufacturing limitation, whilst the Association has the means for ensuring that standards are not lowered to pander to the poorest type of manufacturer. We can envisage no better means of presenting to the engineers succinct statements of foundry progress. It should be clearly understood that this work will not encroach upon the work of the British Standards Institution. One of their jobs is to enunciate minimum requirements and tolerances, whereas the result of the work now being scheduled by the Institute will be average results upon which the engineer can reasonably calculate his designs, when adhering to recognised casting practice.

Foundry Pig-Iron Output.

We have often lamented the fact that there is no definite means of ascertaining whether the foundry trade is improving or not by any statistics of output of castings. Both to the manufacturer of castings and to the supplier of equipment such figures could be of the greatest possible value in showing whether trade is increasing or not and thus act as a basis for plans for the future. One figure, however, is available and that is the figure for the output of foundry pig-iron. Even this is liable to error in interpretation. To a slight extent there is the effect of imports of foundry iron on the one hand and export on the other, neither of any vast importance and both figures are available. Then there is the question of what is foundry pig-iron? No doubt a certain amount of that material classified as foundry pig for purposes of manufacture is actually sold as forge pig, and some of that classified for purpose of manufacture as forge pig is sold as foundry pig. The hematite output is classified on an entirely separate basis from foundry pig, and there is no means of finding out how much of this is used in founding and how much in the steel trade. When all these influences are taken into account two other factors remain. The first is, how much of the output at any given time is going into stock and how much is being absorbed by the trade, and the second is how much scrap is used with pig to furnish the output of castings.

The cost of blowing out a furnace is such, and the cost of restarting is such, that furnaces are put out of commission with great reluctance. Thus they tend to continue in operation during a period of falling demand and the surplus is put into stock, which is used up when the furnace is damped down. Similarly, during a period of rising demand they only come gradually into commission; the former process helps the natural tendency for prices to drop during a lean period and the latter tends to help the tendency to harden during a rising demand. Circumstances thus aid the ordinary course of price fluctuations.

The figures have only been available since 1915, when the war demand for foundry pig was probably less than the normal demand. The post-war period of activity ended in the slump of 1921, which was followed by a period of recovery which ended in the disastrous coal dispute shown in the fall of the returns for 1926. There was a rapid recovery, and another fall starting in 1927, since which the gradual paralysis of world trade has resulted in a further gradual decline which results in an output apparently about two-thirds normal as far as a normal figure can be deduced from such a short period as 15 years containing such violent fluctuations.

There is little doubt that the amount of scrap used with pig has increased since the war, and an average figure is very difficult to assess.

Foundry Selling Practice.

By Eric N. Simons.

(*Continued from page* 348.)

No. 12. SELLING IN RELATION TO THE FIRM.

It is no exaggeration to say that, more often than not, 25 per cent. of the marketing failures of a firm are due to what, for want of a better term, may be called "excessive departmentalisation." Everyone will be familiar with the odd job that Brown says belongs to Jones's department, and that Jones says is anybody's but his, and that between them does not get done at all. That is excessive departmentalisation, and it obtains at its worst in firms whose directors are not so much directors as managers, unless those directors can—which is rare—set aside their departmental prejudices when they come to the board table, and regard the firm as a whole.

Excessive Departmentalisation an Obstacle.

The sales side of a business suffers, perhaps, more than any other, at times, from this same blight. A firm creates a sales department under a sales manager, and then leaves it severely alone to get on with selling. If the sales manager pokes his head round a particular corner with questions and comments, he is politely or impolitely told that that is not his job. Selling is his job, not production or costing or management. In the minds of people of this sort, selling is something that takes place in a vacuum.

Well, selling does not. The firm that sells the castings can be as important a factor as the castings themselves in making sales. And it is the function of the efficient sales manager to poke an inquisitive nose into every department where something is being done that affects his task. For example, if the packing department is sending out the castings in cases so expensive that a definite percentage is added to selling price, and that definite percentage causes orders to be lost, the sales manager has a right to decide whether that form of packing is too good, and if it is, to have it replaced by something cheaper but as effective. Or, alternatively, the packing may be too cheap and need improving. Again, if the delivery promises are not kept, if raw materials are costing too much, if the clerical staff write rude letters to customers, the sales manager is affected, and he must make his views not only known but felt.

Studying the Departments.

The sales manager should, among his multifarious activities, not overlook a consideration of the firm as a whole, and the relations of the various departments to one another. Is each department, he should ask himself, functioning adequately from the sales point of view? If not, in what respects does it fail? Sometimes only a minor detail needs remedying to make a vast improvement in sales. Here a guide of some sort becomes necessary. It is suggested that the various departments should be studied in the following order: (1) Buying; (2) production; (3) technical staff; (4) plant; (5) packing; (6) sales and estimating; (7) costing and accounting; (8) publicity; (9) statistics.

The importance of the buying department in relation to the production department will be governed largely by the percentage of the cost of the finished product represented by raw materials. Obviously, in foundries, raw materials must represent an important percentage. If the sales manager finds that his firm's prices are consistently higher than those of his competitors, there is some excuse for making an inquiry into the prices that are being paid for raw materials. For example, buying may be being done on contract, when it would be better to buy outright, or *vice versa*. The sales department must see that it is working harmoniously with the buying department, by providing some sort of preliminary budget of anticipated sales on which the buyer may base his negotiations; by obtaining information as to the type of raw materials being used by competitors, the prices paid for them, the sources of supply—all of which is strictly sales department work; and finally, by making full use of any special advantages the raw materials purchased possess over those used by competitors, *i.e.*, mentioning them in advertisements, selling arguments, etc.

Production Department.

One now comes to production. Probably the sales manager will find that in so far as any department is highly organised, the production department will be. Nevertheless, he should make it his task to obtain information as to labour turnover—which has an important bearing on production cost—machine records, output figures and records of shipments. For example, one of the most important tasks a sales manager may have to perform is the deciding, based on statistics obtained from the production department, whether it will pay better to make and sell 10,000 castings at £1 each than 1,000 castings at £10 each (reducing the problem to absurdly simple proportions). The point to decide would, of course, be whether the 10,000 castings could be made with a big enough margin of profit to increase the aggregate annual profit of the firm. The sales department must ascertain, in short, not only how much it costs to increase production, but how much production can be economically increased.

When one turns to the third section, technical staff, one touches a thorny bush. But the technical staff is, after all, a factor in sales, and must be considered from that point of view. It often happens that an expert is forced to visit a customer, either to give advice or to investigate a complaint. If the temperament of certain members of the technical staff is such as to render them highly insupportable to customers, then obviously the sales manager should have the power to veto these contacts, or, if this is impossible, to minimise them. One does not in this brief article seem to enumerate every point into which the sales manager should inquire, but only to indicate by a leading example in each case the need there is for close study and co-operation.

Plant.

The plant is another important section, and perhaps its appearance is one of the first sales aspects to be considered. Dirty, ill-lighted, ill-ventilated, old-fashioned shops undoubtedly create a bad impression on the customer or visitor (and it is becoming more and more frequent for buyers to investigate in person the ability of a supplier to meet their needs). But this apart, the sales manager must be vitally interested in such matters as the geographical situation of the plant, and its effect on sales or increased production; its relation to transport facilities; its nearness to markets, raw materials and labour. Other points to be studied are the capacity of the plant, normal and maximum; its ability to manufacture other types of castings; its up-to-dateness; its power consumption; its relations with labour. All these things ultimately affect cost, and cost affects sales. Therefore, the sales manager cannot afford to turn a blind eye to any deficiencies in the plant or its management and situation.

In regard to the other departments, there is no need to go into details at the moment. The next subject to be dealt with in this series will be the important one of sales records.

(*To be continued.*)

Messrs. Arthur G. McKee & Company, engineers and contractors, Cleveland, Ohio, have been awarded a contract from the Ford Motor Company for reconstructing, enlarging and modernising a blast furnace at the Ford plant at Dearborn, Michigan.

Random Shots.

The children clustered round the old man's knee. "And what did *you* do in the Great Depression, gran'pa?" piped a cherub. "Marksman" started in his armchair. "Bless the child, what books she does read!" he quavered. "Why, it was forty years ago that the Great Depression made an end. I was a young man then, but I never did anything extraordinary, unless it was to pretend that there wasn't a depression." "Didn't you ever pay a dividend, gran'pa?" asked another. "No, my dear. That *would* have been extraordinary! I never paid a dividend and I never received one." "Did the tax collectors ever Catch You Out?" asked a third. The old man sighed. "I was never caught out, I fear. I was always Caught In!"

* * *

Certes! a pretty picture. "Marksman," venerable (I hope) and bearded (I expect) relating to his grandchildren the history of the Great Depression (1929-1932). It is, indeed, a history I would like to continue but that the present is too much with us. Might I not, instead, embark upon something more in keeping with the spirit of the approaching holiday? Pantomime, for instance.

* * *

Of course, pantomime, like "Punch," is not what it was. The tinsel is tarnished, the sausages leak sawdust, and the red-hot poker is cold with loss of paint. Pantomime is archaic. Let Hiram P. "Marksman," Hollywood scenario writer, rejuvenate it for you:—

In *Act I* Jimmy is working by candlelight in the foundry. All his fellows have hied themselves to the T.U. whist drive and dance. The Fairy Foreman enters via the cupola shaft. "You shall go to the dance," he cries. He does his wand stuff by transforming an electric truck into a limousine car, the foundry's pet rat into a chauffeur, Jimmy's moleskins into evening dress. *Act II* introduces the brilliant scene of the T.U. whist drive and dance. Jimmy, having won all the prizes, is dancing with his employer's daughter. He is about to propose to her when two o'clock strikes. "I must go," he says, and dashes off, leaving his job-card lying on the floor. *Act III*, the last, finds the employer's daughter, who is Cinderella, in the foundry. She has discovered who Jimmy is from the local Branch secretary. With the aid of her black magic supplement from "Home Notes" she summons the Fairy Foreman. "Unless you make Jimmy rich for life I shall put you into the cupola," she says. The Fairy Foreman hands to Jimmy a packet of shares in a core-oil business and turns into a one-off casting. The Wedding March is played as the curtain falls.

* * *

Questions on custom of the trade have cropped up suddenly. So much uncertainty exists that it seems quite wonderful that any customs should ever have been established; or, being established, have survived. Then situations arise which do not appear to be governed by a custom of the trade. Several instances come to mind. A competitor, for example, captures your best customer by quoting ridiculously low prices. What is to be done? The custom of the trade should be clear: write to the competitor offering to loan him elementary handbooks on costing and estimating. Again, a foundry-requisite merchant offers your foreman commission on the purchases he makes of that merchant: you inform the merchant that if he usually does business like that, he should deal directly with you. "Marksman" was intended for the Bar—in a legal sense.

Marksman.

XUM

Some Recent Developments in Automobile Cast Iron.*

By T. R. Twigger.

The automobile industry occupies an important place in regard to the manufacture of cast iron on account not only of the tonnage consumed but also of the demands it makes for the production of a special high-grade material to meet the ever-increasing severity of working conditions. Far from cast iron being gradually superseded by other materials as at one time appeared possible, the development of special types of material has enabled the use of cast iron to be advantageously extended. This would obviously not have been possible without a better understanding of the nature of the material itself, the ability to obtain improved properties, and the increased confidence of the designer or user.

Developments during the past few years have generally sprung from the necessity for improved service although the need for renewability of wearing parts, especially on commercial vehicles subjected to heavy duty, has been a contributory factor. From both points of view the principal components to be considered have been those which are either wearing or reciprocating parts of the engine, as for example, the cylinder bore, valve seats, valve guides, pistons and tappets as shown in Fig. 1. Although an important wearing component of the chassis, the brake drum has recently provided a further application of cast iron.

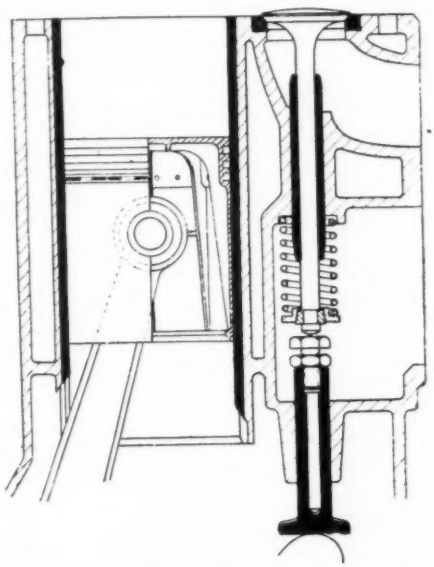


FIG. 1.—CYLINDER BLOCK, SHOWING LINER, VALVE GUIDE, PISTON AND PISTON RINGS, VALVE SEAT AND TAPPET AS THE PRINCIPAL WEARING PARTS.

The improvement of cast iron is usually concerned with either:—(*a*) increasing the hardness or strength of the metallic matrix, or (*b*) reducing the size and sometimes the quantity of the graphite flakes by which the matrix is broken up.

There has been no lack of suggestions during the last few years for improving the quality of cast iron, in fact it has been no easy task for those engaged in works practice to weigh up the possibilities of the various proposals in the light of the engineer's demands and the potential sales possibilities for material of improved properties. Three methods of improvement which have been established on a definite commercial basis are the use of centrifugal castings, alloy additions and heat-treatment. These are in turn discussed below with special reference to conditions (*a*) and (*b*) mentioned above.

Centrifugal Castings.

The centrifugal process which has now been in fairly extensive use for a number of years has already been described and the principle of the process is generally fairly well known. It is sufficient here to say that molten metal is poured into a mould (usually metal) rotating at high speed. The action of the centrifugal force which throws the metal to the outside of the mould where it solidifies to form a hollow cylinder, whilst ensuring that the slag and other impurities are directed to the inside of the casting and are generally eliminated by a little excessive metal which flows into or over the "front plate" closing the mould.

Apart from facilitating the production of hollow castings especially suitable for cylinder liners, valve seats and brake drum liners the use of metal moulds ensures a much closer grain than is generally possible with sand castings, also the graphite is much more finely divided thus meeting condition (*b*) as is shown by Figs. 2 and 3.

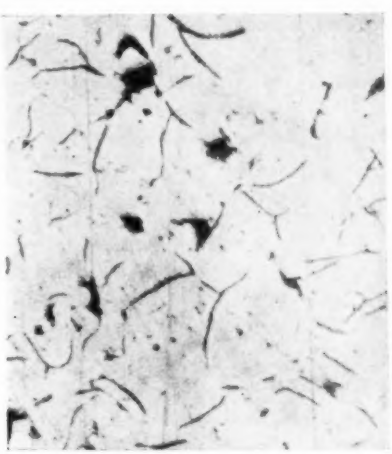


FIG. 2.—GRAPHITE IN SAND-CAST PISTON-RING IRON. UNETCHED. × 120.

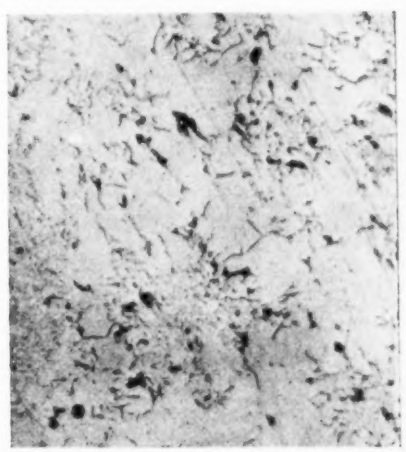


FIG. 3.—GRAPHITE IN CENTRIFUGALLY-CAST PISTON-RING IRON. UNETCHED. × 120.

While the centrifugal process brings in its own peculiar difficulties with regard to defects the castings made by it are generally free from the porosity often found in sand castings. It will be noticed that the use of hollow cylindrical castings for cylinder liners, valve seats and brake drum liners is of great assistance in connection with the renewability of wearing parts, a point which is of great importance in the commercial vehicle industry. There is the additional advantage with these renewable parts that they can be made from material specially designed to resist wear, and provision can be made if desired for such special wear resisting components to be fitted in the original engine.

Alloy Additions.

Additions of special elements are designed mainly to improve the hardness or strength of the metallic matrix (condition (*a*)) but also to some extent to reduce the size of the graphite flakes (condition (*b*)), as for example, nickel, providing the silicon is correspondingly reduced, enables a closer grain and smaller graphite flakes to be produced. Nickel and chromium are the elements in fairly common use, but molybdenum and vanadium are receiving attention. Nickel and chromium most certainly have their uses but it is very doubtful whether in the small percentages normally used they exert very much influence on either the strength or resistance to wear of the casting. Their chief benefits seem to be as an aid to the founder in producing sound castings where the design is such that difficulty might otherwise be experienced. The writer has known many cases of castings where by the use of nickel in conjunction with chromium the tendency towards porosity in heavy sections has been considerably lessened.

Considered from the standpoint of wear, which is the main consideration in the commercial-vehicle engine, there is little evidence to show that nickel in itself, even when the silicon is reduced, increases the life. Chromium, though acting as a hardener, may exert some influence in this respect, but in the commercial-vehicle field at any rate small improvements, although acceptable up to a point, do not really solve the problem, because service conditions are so severe that something giving very much improved life is looked for. Chromium is useful from the point of improving the resistance to heat, this being of relatively little importance in connection with cylinder liners, but quite important in connection with valve seats which are exposed to the high temperature of the exhaust gases, and also in connection with brake-drum liners, which frequently get a high surface temperature due to friction of the brake-shoe lining. For these two components it is suggested that the chromium should be at least 0.5 per cent. Tests carried out by Donaldson* showed clearly the influence of chromium in minimising the reduction of combined carbon at

TABLE I.—*Thermal Conductivity of Various Cast Irons.*

	150 deg. C.	400 deg. C.
Ordinary good quality iron—		
No nickel. No chromium ..	0.12 units	0.107 units
0.75 per cent. nickel. No chromium	0.107 „	0.101 „
No nickel. 0.2 per cent. chromium	0.125 „	0.111 „
No nickel. 0.4 per cent. chromium	0.128 „	0.115 „
Austenitic cast iron: nickel, 14 per cent.; copper, 7 per cent.; chromium, 2.5 per cent.	0.101 „ (At 100 deg. C.)	0.095 „

* A Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen. Mr. F. J. Hemming presiding.

* Donaldson, Proc. I.B.F., 1928–29, p. 128.

temperatures of 450 deg. C., at which ordinary iron may show an appreciable change after prolonged heating.

Thermal Conductivity.

It is interesting to notice that chromium, while increasing the hardness, leaves the material relatively easy to machine even when the chromium is sufficiently high to give a definitely mottled structure. Chromium also increases the heat conductivity of cast iron, while nickel reduces it. The percentages detailed in Table I show fairly small differences, but these are by no means too small to take into account.

TABLE II.
MECHANICAL TESTS ON HARDENED AND TEMPERED CAST IRON.
(CENTRIFUGALLY CAST)

Sample 5.0/K.65.	Brinell.	Modulus of Rupture Tons per sq. in.	Elasticity Value. Lbs per sq. in.	Permanent Set at 14 tons per sq. in.	Direct Tensile Tons. per sq. in.
As cast.	230	29.3	16.1×10^6	13.6%	15.6
Oil Hardened 830° C	426	26.0	12.7×10^6	17.1%	12.6
Oil Hardened 830° C Tempered 350° C for 15 minutes.	437	33.5	13.9×10^6	4.6%	16.13

Sample 4.5/0.85.	Brinell.	Modulus of Rupture Tons per sq in.	Elasticity Value. Lbs per sq. in.	Permanent Set at 14 tons per sq. in.	Increase in gap opening at fracture
As cast.	240	30.5	16.4×10^6	13.3%	.859"
Oil Hardened 830° C	472	25.2	14.0×10^6	12.6%	.824"
Oil Hardened 850° C Tempered 300° C for 20 mins.	415	34.0	14.4×10^6	7.1%	1.012"
Oil Hardened 830° C Tempered 350° for 20 mins.	382	34.0	14.4×10^6	6.5%	1.039"
Oil Hardened 830° C Tempered 450° C for 20 mins.	322	32.3	14.5×10^6	8.0%	.954"
Oil Hardened 830° C Tempered 500° C for 20 mins.	283	29.5	14.85×10^6	7.2%	.857"

Expansion Curves.

The amounts of alloys added are, generally speaking, small, except for irons of very special properties, as, for example, martensitic irons or austenitic cast irons containing high percentages of nickel, copper or manganese and sometimes chromium. Austenitic irons have a much greater coefficient of expansion than ordinary grades of cast iron and approach the coefficient of expansion of aluminium alloys. They have, therefore, possibilities in the direction of renewable parts, such as cylinder liners or valve seats fitted into housings of aluminium alloy. Such a construction may result in a great saving in weight. Coefficient of expansion tests on centrifugally-cast samples of austenitic iron and ordinary cylinder iron are shown in Fig. 4.

Irons which are martensitic as cast due to large percentages of nickel, chromium or manganese which render the material costly and exceedingly difficult to machine, would appear to have little advantage as regards automobile practice over other irons of more normal composition in which an equally hard martensitic structure can be obtained by heat-treatment.

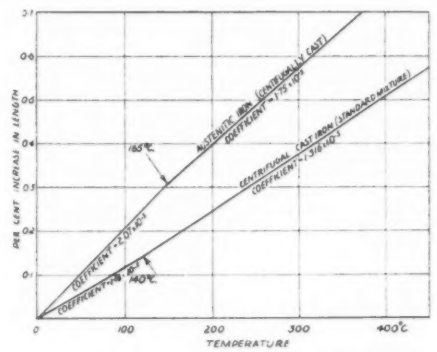


Fig. 4.—Expansion Results in Austenitic and Ordinary Cast Iron.

Heat-Treatment.

This is perhaps the most outstanding development in cast-iron metallurgy in recent years. Heat-treatment of grey cast iron for the removal of casting strains for improving machinability has long been practised, but increasing the hardness by hardening and tempering, although the principle has long been known and was, in fact, used nearly 20 years ago by the firm with which the author is connected, does not seem to have been applied very much commercially until the last few years. This was partly due to the lack of metallurgical knowledge which now enables the process to be put on a proper footing, and partly for lack of commercial stimulus which the present demand for better wearing properties provides. The hardening property of cast iron or steel depends on the fact that above the critical point the carbon in solution can be retained in the hard martensitic form by suitable quenching.

In the case of steel the whole of the carbon is usually in solution above the critical point. With cast iron the amount of carbon in solution will depend on the composition of the material and the temperature to which it is heated. Silicon, nickel and other elements which tend to precipitate carbon from the solid solution reduce the amount of carbon in solution at any given temperature and elements such as sulphur, manganese and chromium which normally harden cast iron will increase it. It follows that the extent to which cast iron must be heated above the critical point in order to secure a satisfactory hardness on quenching will depend on its chemical composition. In addition, the actual critical point itself is influenced by the chemical composition—silicon, for example, increasing it and nickel and manganese reducing it.

The hardening operation is usually carried out on the articles finished except for final grinding, as, generally speaking, the material is too hard to machine after hardening except by using

TABLE III.

CYLINDER WEAR RESULTS.

The following results are expressed as the number of miles run per 0.001" of cylinder wear. Except where otherwise stated liners are Centrifugally cast.

		Type of Liner	Rings	Pistons	No. of Miles per .001" wear
A.1.	1.	Low Silicon with 1% nickel	Standard Cast Iron	Bi metal Aluminium Head.	2.440.
	2.	Special Iron (No Analysis given)	"		1.786.
	3.	1% nickel .5% Chromium.	"		2.277.
A.2.	1.	Standard Mixture	Standard Cast Iron	Bi-metal Aluminium Head	2.300.
	2.	Standard Mixture Hardened & Tempered	"		4.000.
B.	1.	Standard Mixture Hardened & Tempered	Standard Cast Iron	Aluminium	2.692
	2.	Standard Mixture Unhardened	",	Cast Iron	4.576.
	3.	Standard Mixture Hardened & Tempered	"	Cast Iron	5.601.
C.	1.	Standard Mixture Hardened & Tempered	Cast Iron Hardened and Tempered	Cast Iron	18.000.
	2.	Standard Mixture Hardened & Tempered			6.000.
D.	1.	Standard Mixture Hardened & Tempered	Standard Cast Iron.	Aluminium	5.222
	2.	Standard Mixture Hardened & Tempered			3.666 } 4.250.

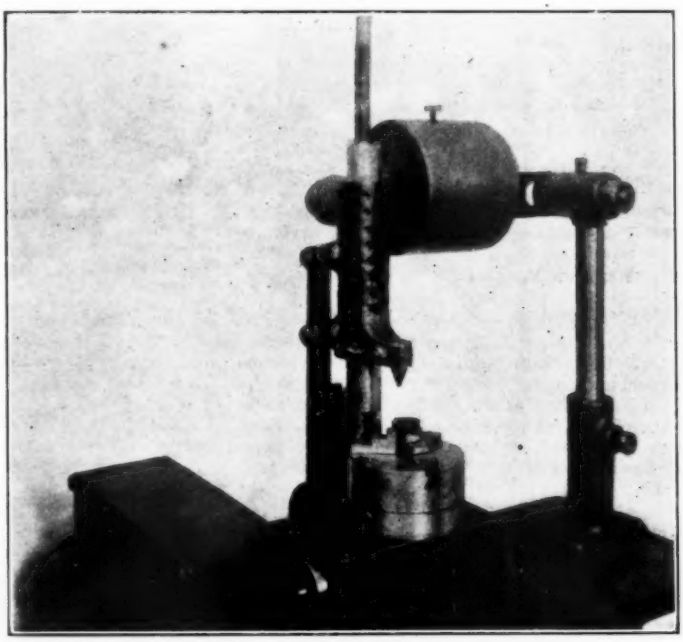


Fig. 5.—Repeated Impact Testing Machine.

special cutting tools or by grinding. It can, however, be tempered to a hardness value between that of the as-cast material and the fully hardened, so that it is possible to secure a part which, although much harder than the original material, is sufficiently soft to be machinable with special tools.

This plan is adopted in heat-treating valve-

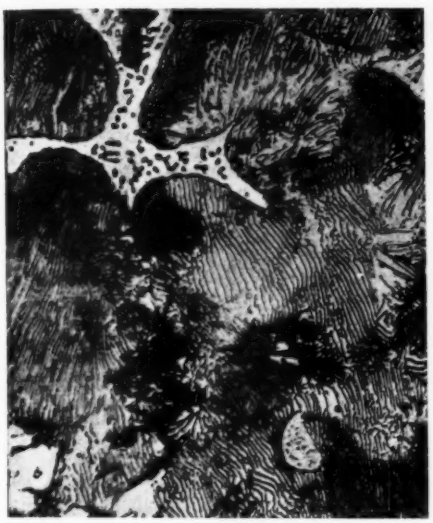


FIG. 6. — CENTRIFUGALLY-CAST CYLINDER LINER. ETCHED STRUCTURE. × 1,000 DIAS.

seat inserts, where it is very desirable to cut the actual valve-seat after pressing in the insert in order to secure perfect squareness of the seating with the valve stem.

Numerous tests have been carried out to determine the mechanical properties of hardened and tempered cast iron. Tests made some five

FIG. 7.—CENTRIFUGALLY-CAST LINER IN THE HARDENED AND TEMPERED CONDITION. ETCHED STRUCTURE. × 1,000 DIAS.

years ago by the writer included tensile, elasticity, Brinell, etc., and also the effect of time and quenching in both oil and water, as a result of which oil quenching was adopted as the standard practice. Some results have since been published by Hurst.* Some recent tests carried out by the writer are summarised in Table II.

* J. E. Hurst, "Oil Hardening and Air Hardening Cast Iron," FOUNDRY TRADE JOURNAL, December 4, 1930.

It will be noticed that the samples, which had a chemical composition approximately as follows: Total carbon, 3.35; combined carbon, 0.60; silicon, 2.10; sulphur, 0.09; phosphorus, 0.45; manganese, 0.70; nickel, 0.50; and chromium, 0.20 per cent., contain no large amounts of nickel and chromium. In a recent publication† it is suggested that heat-treatable iron for cylinder liners and valve guides should have 3.0 per cent. nickel. In the works with which the writer is associated thousands of valve guides have been hardened by heat-treatment without any trouble with warping and distortion, and the oil hardening of cylinder liners has been a commercial operation for several years without any trouble due to cracking in hardening. While it is agreed that nickel enables a lower quenching temperature to be used, this is only of the order of 20 deg. C. for 1 per cent. of nickel added. The tests shown in Table II were made with the object of determining more exactly the effect of tempering at various temperatures, and in order to try and get some evidence of the degree of brittleness of hardened and tempered cast iron as compared with as-cast.

The test-pieces for modulus of rupture, elasticity value and permanent set were in the form of annular rings cut from the castings. The modulus of rupture is obtained by pulling apart in a small tensile machine a split ring as

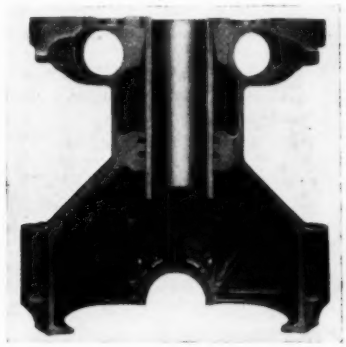


FIG. 8.—CENTRIFUGALLY-CAST "WET" LINER.

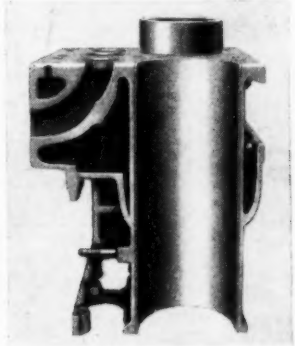


FIG. 9.—CENTRIFUGALLY-CAST "DRY" LINER.

detailed in the B.E.S.A. specifications 5004 and 4.K.6 for piston-ring pots. These specifications designate this as a tensile test and the formula given incorporates a factor for expressing the results in terms of tensile. This involves a constant of 1.6, which is low as compared with the figures of 1.8 and 2 looked upon as a more normal relation between transverse breaking test and tensile. The results of the test have, therefore, been expressed as modulus of rupture as being less open to objection than the tensile-strength equivalent.

The direct tensiles obtained on small test-bars cut from the same casting as used for ring tests are given in column 5 of Table II. It will be seen that not only are the direct tensile results in the same order as the modulus of rupture, but that the relationship of transverse strength = twice tensile, holds fairly closely in each case. The tests on tempered samples clearly show the improvements resulting from this operation as compared with the quenched samples. The tempered samples show little reduction in hardness, but the modulus of rupture and tensile strength which are definitely low on the sample hardened only recover on tempering to a figure in excess of the as-cast sample. There is a drop in the elastic value of both hardened and hardened and tempered samples. In this respect the writer's results do not quite confirm those given by Hurst,‡ the reason possibly being that the writer's tests were carried out in the manner specified under the B.E.S.A. specification, while Hurst's results were carried out by applying the load in the opposite direction, and it is not certain that the same formula would hold.

The permanent set value in column 4 of Table II indicates that the hardened and tempered material deforms much less under load than in the as-cast condition. These tests are carried out by stressing test-rings as already described, by stressing to 14 tons per sq. in., and calculated by the formula given for the tensile tests in B.E.S.A. specification. The above figures are the results of tests made on the first stressing as compared with the second stressing results given by Hurst. It might be inferred from the relatively high permanent set values obtained on hardened samples that this material is more ductile than the tempered samples. This is not borne out by experience, as the hardened material is invariably more brittle than after tempering. It would appear that the apparently high permanent set is due to the fact that in the case of the hardened material the stress at which the permanent set is measured (14 tons per sq. in.) is very near to the ultimate breaking strength of the material as compared with the as-cast and tempered samples. There would appear to be a little inconsistency in the results on sample 5.0/E65, where the Brinell hardness is shown as higher after tempering than on the sample hardened only. This is not generally the case, as will be seen from the results on sample 4.5/G85, which is typical of many other tests carried out. The reason for including 5.0/E65 was to include the "direct" tensile tests which were not carried out on other samples.

An attempt has been made to approximate the brittleness from the gap opening of the ring before fracture, but it would appear that the gap opening, depending as it does on the tensile strength, the elasticity of the material, and the permanent set, has no direct connection with brittleness.

In order to obtain definite evidence on this matter, tests have been carried out on the special repeated-impact testing machine illustrated in Fig. 5. This machine was constructed primarily for testing chilled-face cast-iron tappets. The tappet of the rotating mushroom-head type is held in the chuck and subjected to four blows per revolution from the hardened steel hammer. The dead weight on the beam can be varied to suit designs of differing sections. Tests carried out on this machine have indicated a very definite increase in the number of blows required to fracture in the case of hardened and tempered material as compared with the same material as cast, irrespective of whether or not the face was chilled (as is normally the case with tappet heads). This conclusion has been amply confirmed by recent repeated impact tests on a Stanton machine.

The martensitic structure of hardened and

† FOUNDRY TRADE JOURNAL, October 29, 1931.
‡ J. E. Hurst, *loc. cit.*

tempered cast iron as compared with the pearlitic structure of the same material as cast is shown in Figs. 6 and 7. As the temperature increases, the martensite breaks down into troosite and sorbite, with reduction of hardness and reduction in transverse strength, as shown in Table II, if the tempering temperature rises to more than 450 deg. C. Having outlined the chief developments which have taken place in recent years and principles underlying them, one or two examples of their application may be given.

Cylinder Liners.

Cylinder liners of either of the wet or dry type, illustrated in Figs. 8 and 9, are in common use. Dry liners which enable a worn cylinder block to be readily brought back to standard, thus avoiding the necessity for oversize pistons and piston rings, were found to be the only logical way of dealing with the acute cylinder wear problem in commercial vehicle engines consequent on the increased severity of service conditions. From the point of view of facilitating subsequent renewal, some manufacturers fit dry liners in the original engine. Others rely on obtaining a reasonable first life from the cylinder, leaving subsequent renewal to the user. Wet liners, while still retaining the feature of renewability, aim at avoiding any possibility of imperfect heat flow through the pressed-in dry liner to the cylinder block and water jacket. They enable the cylinder block to be greatly

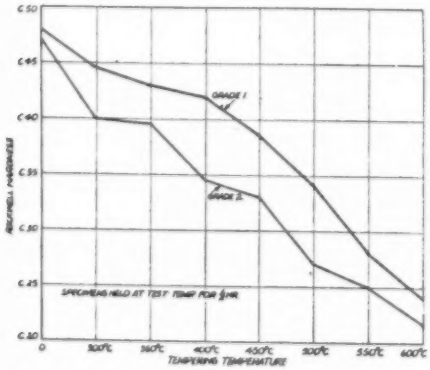


Fig. 10.—Showing Diminution of Hardness with Increasing Temperature.

simplified, and permit the use of cylinder blocks of light alloys, with consequent saving in weight.

It will be noticed that both wet and dry liners enable the cylinder bore to be of material specially designed to resist wear. Both lend themselves to hardening and tempering on the lines already described. Some figures obtained from tests in commercial vehicles are given in Table III. These represent typical service results, the liners of different materials generally being fitted alternately in the same engine. Engine conditions vary so widely that it is unsafe to draw conclusions except from "side by side" tests. There are, however, unmistakable increases in mileage per 0.001-in. cylinder bore wear where cast-iron pistons are used and with hardened and tempered liners as compared with unhardened liners or the original cylinders. Cylinder wear should always be expressed as miles run per 0.001-in. cylinder bore wear. Figures recently published* showing the depth of wear, *i.e.*, half the cylinder bore wear, may lead to confusion in comparing results.

Cylinder liners whether wet or dry are invariably made from centrifugal castings and do not normally contain more than small percentages of special elements such as nickel and chromium. Unhardened, they usually have a Brinell hardness of approximately 220-240, while they may range from 400 to 500 in the hardened and tempered condition. For commercial vehicle fleets where mileages of 50,000 (roughly equal to a year's work) or even 80,000 miles before dismantling the engines are aimed at, the use of hardened and tempered cylinder liners is almost a necessity.

Valve Seats.

The wear on valve seats in commercial vehicle engines is a problem of almost equal importance to cylinder wear. Inserts machined from centrifugal castings are widely adopted for renewing a worn seating. The special conditions of resistance to heat and resistance to the hammering of the valve call for special consideration of the material.

The composition given in Table III appears to be satisfactory. This is used either in the normal condition or hardened and tempered to a Brinell of approximately 300 at which the actual valve seating may be machined after pressing the insert into the cylinder block. The use of austenitic cast iron which appears satisfactorily to resist heat has possibilities particularly in aluminium cylinder blocks where the higher coefficient of expansion of austenitic cast iron as compared with ordinary iron is an advantage.

The results of some tests carried out to determine the reduction in hardness of hardened and tempered valve seat samples at various temperatures are shown in Fig. 10. Grade II being material of normal composition (nickel 0.5 per cent. and chromium 0.2 per cent.) and Grade I similar in composition except that the chromium was approximately 0.75 per cent. It will be seen that although the sample had originally similar hardness values indicating that the chromium was not a necessity in securing the increase in hardness in heat-treatment it had the effect of rendering the hardened structure more stable under heat.

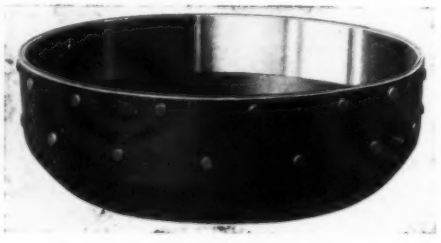


Fig. 11.—Steel Brake Drum fitted with Centrifugally-cast Liner.

Valve Guides.

In recent years considerable trouble with valve stem and valve guide wear has been experienced coincident with the adoption of modern austenitic valves which are relatively soft compared with the steels formerly used. Numerous cases have been found of the valve stem picking up on the valve guide, this, of course, being very pronounced if there is any appreciable side thrust on the valve stem. While in some cases the addition to the valve guides of nickel up to 1 per cent. and chromium up to 0.5 per cent. appears to effect an improvement, the use of hardened and tempered valve guides appears to be the most certain means of overcoming the difficulty. This confirms the theory that to secure a good wearing combination bearing metals should generally show a considerable difference in hardness, as for example hardened steel running in conjunction with phosphor bronze. An exception appears to be cast iron with cast iron which as-cast or hardened and tempered forms an excellent combination.

Brake Drums.

While it is agreed that cast iron is unquestionably the most efficient brake-drum lining material there is no general agreement as to the best method of application. For small drums a complete drum of special cast iron may be considered satisfactory. For larger drums, especially those used on commercial vehicles, a drum of steel or aluminium alloy with a cast-iron liner machined from a centrifugal casting is a more satisfactory design. Where it is desired to use aluminium drums the aluminium may be cast round the liner, the latter being grooved to form keys which prevent the liner from rotating, or the liners may be of austenitic cast iron which will expand at a similar rate to the aluminium drum.

As a means of renewing worn steel drums the method of pressing in a liner of centrifugal cast iron is firmly established. The liners (shown in Fig. 11) which are machined about 0.010 in. to 0.015 in. greater on diameter than the bored out drum are riveted to the drum after pressing in, using, preferably, two rows of rivets about 3 to 3½ in. pitch. The riveting is done purely as a "safety first" measure in the unlikely event of the interference fit being insufficient to prevent the liner rotating. Drums

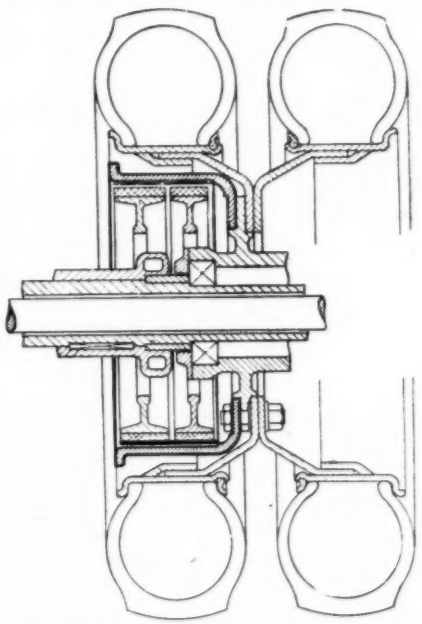


Fig. 12.—Showing in Black the Brake Drum illustrated in Fig. 11.

treated in this way show no signs of wear or surface cracking after 40,000 miles and there appears no reason why they should not give a life of up to 80,000 or 100,000 miles which is far in advance of that obtainable from most steel drums. With a lining of cast iron the brake shoe linings which, it is found, should not be of the wire-bonded type, give greatly improved life.

The drums may be fitted with liners in the first place, not so much from the point of view of facilitating renewal but to secure the best wearing material—in fact greatly to minimise the necessity for subsequent renewal. A composite construction—cast-iron liner in a steel drum—has a considerable advantage as regards lightness and consequent reduction of "unsprung weight" as compared with an all cast-iron drum.

In conclusion the author would express his thanks to the British Cast Iron Research Association for providing the figures on thermal conductivity (originally determined by Dr. J. W. Donaldson) and coefficients of expansion, also to Mr. W. A. Oubridge, M.I.Mech.E., managing director of The British Piston Ring Company, Limited, for permission to give this Paper.

Mr. Hore-Belisha, Parliamentary Secretary to the Board of Trade, intends to make a tour of the iron and steel districts during the Parliamentary recess. He will be accompanied by an official of the Board of Trade.

* Foundry Trade Journal, October 29, 1931.

The Manufacture of High-Grade Castings in the Brackelsberg Rotary Furnace.*

By Peter M. Macnair, Ph.D., B.Sc., A.I.C.

Historical.

The manufacture of cast iron is one of the oldest of the arts carried on in our great industrial country. In the fourteenth century it became a regular metal of commerce, and right down to the present day cast iron has remained a vital necessity to practically every industry. It is only natural that there should be many improvements in the methods of manufacture of such a widely used material. More satisfactory castings and methods of production have been evolved according to the prevailing demands of the different periods. Within the present century, however, these demands have become more insistent, and consequently the developments more rapid.

Although the outline of the cupola can be traced back through early blast furnaces to the Stückofen and the very primitive furnaces of the pre-Christian era, yet our modern cupola may be said to begin with the patent design of John Wilkinson taken out in 1794. There have been many advances in design and auxiliary machinery since this date, but the cupola has remained until the present as a most economical and satisfactory method for the production of cast iron.

However, it is known that the cupola has well-defined metallurgical limitations, which have necessitated additions to it, or its replacement by another type, or its use in conjunction with another type, such as is carried out in duplexing. As an optional method of smelting to the cupola, mention may be made of the use of crucibles, air furnaces, open-hearth gas-fired type of furnaces and electric furnaces. These have a limited and specialised use owing to their heavier installation and operation costs. It has, therefore, been realised for some time that there was a growing necessity for a new furnace which would eliminate the metallurgical disadvantages of the cupola, and at the same time be able to produce at a similar or lower cost. Such a furnace is now available as a commercial proposition in the rotary pulverised-fuel furnace.

The first successful practical rotary furnace for cast-iron manufacture was patented in this country by Karl Brackelsberg in April, 1927, and is now more familiarly known as the Brackelsberg furnace. There have been many modifications and improvements during the last four years, as further experience was gained on the 40 to 50 plants installed throughout the world. While the greatest advances have naturally come from the wider experience of the Brackelsberg furnace, it has also to be noted that this type of furnace has been taken up by other manufacturers. Among these may be mentioned the Sesci, who took out a patent two years later in July, 1929, the Sklenar in 1931, and also the Buess furnace.

Descriptions of the Brackelsberg furnace have already appeared in the more important technical journals, so it is not necessary to give a detailed account of its construction and operation. It is the aim of the present Paper rather to discuss some of our modern ideas on how improvements can best be obtained in the properties of cast iron, and to illustrate the extent to which this is accomplished in rotary pulverised-fuel-fired furnaces.

Alloy Iron Manufacture.

Perhaps the best known, because it is typical of the present metallurgical age, is the production of the so-called alloy cast irons. By the addition of varying quantities of special elements, such as nickel, chromium, vanadium, molybdenum, high silicon and manganese, etc., the structure of the cast iron may be considerably modified to give particular properties, such as high resistance to shock, good tensile strength and hardness with ease of machinability, resistance to corrosion, etc. A considerable field has been opened up here, which will undoubtedly increase in the future. Naturally, these additions increase the cost of the iron, but this is offset by longer life or reduction in total weight to give equivalent service.

As an alternative to alloy irons, various processes have been evolved, which base their improvement on the quality by an improvement in the conditions of melting. Taking the cupola as normal practice, there are such modifications as use of forehearth, air furnaces, open-hearth furnaces, electric furnaces, duplexing and even triplexing, the Lanz hot-mould process, Emmel iron, Hanemann process, Corsalli process, Deschene process, production of so-called semi-steel or, its later name, high-test grey iron, Meehanite iron by the addition of calcium-silicide, etc. All these modifications are essentially evolved in order to overcome the limitations of the cupola-melted metal. What, then, are these limitations?

Low-Carbon Irons.

In the first place, there is the total-carbon content of the cast iron. Where strength and toughness are required, the size and the quantity of the graphite flakes are an important factor. Obviously, the higher the carbon the greater are the number and size of the graphite flakes, other things being equal, and the weaker is the cast iron. So far as relative quantity of these weak lamellæ is concerned, it is an advantage to have the total-carbon content as low as possible. Actually 2.8 to 2.9 per cent. is now regarded as a suitable figure, as with lower contents other troubles may become more serious. Attempts to reach this figure have been made in the cupola by the production of so-called semi-steel, due to the large proportion of steel scrap in the charge. In capable hands, satisfactory results have been obtained, but the uncertainty is great. The carbon pick-up in the cupola is uncertain and erratic, depending on temperature, nature of charge, reactivity of the coke and time of contact. In the Brackelsberg furnace, however, the metal is not in contact with the fuel, is covered with slag, and consequently does not pick up carbon. As a matter of fact, there is always a carbon loss due to oxidation, so the tendency is to produce a lower carbon metal.

The total quantity of carbon is under absolute control in rotary furnaces, and can be varied from 2 to 3½ per cent. as desired. The charge is made up so as to get the required finishing carbon, due allowance being made for slight oxidation losses. When the furnace is almost ready, a test sample can be drawn and the final composition adjusted by the addition of anthracite or oxidising out more carbon with an addition of scale.

Coal to Air Ratio Control.

The fine control on the ratio of coal to air is an important asset in the operation of the Brackelsberg furnace. It is often claimed for this type of firing that a neutral atmosphere can be obtained, or even a reducing atmosphere. This is not strictly correct. Heat is usually generated by the combustion of coal by oxygen. The reaction is

$$C+O_2=CO_2+98{,}500 \text{ cals.}$$

Unfortunately excess air is generally required, which acts deleterously in that it absorbs some of the above heat, and also in that free oxygen tends to oxidise iron and other elements directly.

With no excess air it is usual to say that the flame is neutral. With insufficient air one does not get the full heat generated as carbon is burned only to carbon monoxide

$$C+O=CO+30{,}300 \text{ cals.}$$

In order to get maximum possible efficiency, it is therefore necessary to aim for complete burning of coal to carbon dioxide.

If there is free oxygen in the gases then iron oxide is formed; if there is excess CO_2 in the gases there also is iron oxide formed according to the reaction

$$Fe+CO_2 \rightleftarrows FeO+CO.$$

The above is a reversible reaction with equilibrium at high temperatures all on the right-hand side at practically 100 per cent. CO. As a consequence iron in contact with CO_2

Table I. Heat Generated by Various Coals.

Coal Analysis.	Bituminous. Low Ash. Low H_2O.	Low Ash. High H_2O.	High Ash. Low H_2O.	Anthracite, Good Quality.
Carbon.	76%	69%	69%	88%
Hydrogen.	5	4	4	2
Oxygen.	7	6	6	2
Nitrogen.	1	1	1	0.5
Water.	5	15	5	2
Sulphur.	1	1	1	0.5
Ash.	5	4	14	5.0
Calorific Value B.Th.U.	13,400	11,900	11,900	13,900
Air to burn. cu. ft/lb coal.	133.4	118.7	118.7	140.4
Theoretical Flame Temperature. deg.C.	2010	1960	1965	2020
Lbs. coal required to get same B.Th.U.	1.04	1.17	1.17	1.00
Air required for above.	10.67	10.68	10.68	10.80
Flame temperature at same B.Th.U. allowing for radiation loss. Cold Air deg.C	1,635	1,600	1,625	1,640
Effect of preheated air to 300 deg.C. on flame temperature at same B.Th.U. deg. C.	1,725	1,690	1,720	1,730
Ignition Temperature. deg.C.	400	400	400	500

* A Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen. Mr. F. J. Hemming presiding. The author is metallurgist to Messrs. James Howden & Company, Limited.

tends to be oxidised to iron oxide with formation of CO. The rate of oxidation by CO_2, however, is very much less than by oxygen itself so that by keeping free oxygen down to a minimum, oxidation losses are considerably reduced.

It is here, again, that pulverised-fuel furnaces hold an advantage. There is absolute control of the ratio of oxygen to fuel, which is in a fine state of division and completely burned with practically the theoretical quantity of air. It is thus possible to get the hottest flame with all the advantages of quick melting, and also an atmosphere which causes minimum oxidation losses. It is of interest also to note that in the Brackelsberg furnace any type of coal can be used for pulverising. Of course it is desirable to keep the moisture and ash contents within reasonable limits, otherwise there is an increase in coal consumption to get the same effect. Table I shows the effect of an increase of 10 per cent. in ash or moisture, and also the relative heating power and flame temperatures obtained with anthracite and bituminous coal.

The importance of total carbon has been touched on; attention might now be directed to the importance of the solubility of carbon in iron. It is known that the solubility of carbon increases with temperature so that with a hot melt there is a tendency to pick up excess carbon. When such metal is cast and allowed to cool down, it throws out this extra carbon in the form of kish, because the solubility becomes less as the temperature is lowered. On solidification of the iron in presence of silicon the solubility is very much less than in the liquid state, and consequently more carbon is thrown out as graphite. These particles of graphite thrown out from high-carbon metal in a liquid state form nuclei on which more carbon is deposited, until finally they become of such a size that they can rise to the surface and appear as kish. Again the metal must also be saturated with these nuclei so that when solidification occurs the additional graphite thrown out grows from these centres with consequent formation of large flakes and production of inferior strength castings. These nuclei are also detrimental in producing a large-grained structure in the iron itself, whereas close-grained material gives much better mechanical properties.

With rotary-type furnaces this complication is eliminated, because the metal can be kept so low in carbon that the total amount present is less than that required for solubility of carbon at the solidification temperature. Superheating the metal does not give any carbon pick-up—in fact, it tends to a reduction owing to chemical reaction with the slag—and on cooling down after casting there is no tendency to throw out carbon nuclei until solidification is actually taking place. The fact that solidification and graphite deposition are taking place simultaneously then prevents excessive growth and forms the flakes in a very fine state, so desirable for good strength combined with reasonable machining properties.

Another aspect of this solubility problem is the well-known difficulty of re-dissolving the graphite on re-melting pig-irons. It requires superheat to do this, which brings on the difficulty, already mentioned, of a further carbon pick-up, and then a repetition of the old trouble on cooling. As a consequence, it has been found necessary to use special "refined" pig-irons and special-quality irons, which tend to remelt completely without leaving graphite nuclei behind. More especially is this the case in air-furnace practice, where superheat is difficult to obtain, and the high quality desired from the finished chilled rolls demands metal free from depositing centres.

The superheat which can be obtained in the Brackelsberg furnace—it is possible to get it sufficiently hot to melt steel—enables any type of charge to be used with the certainty that all graphite will be dissolved and a homogeneous melt result. Table II clearly illustrates the advantage of the Brackelsberg furnace in this direction. In the tests carried out the charge varied from 50 per cent. pig and scrap to 100 per cent. borings and 100 per cent. steel turnings, yet the mechanical properties of the finished irons were very good, due to the production of homogenous metal free from gas and nuceli.

Table II.—*High-Test Iron, Manufactured in Brackelsberg Furnace.*

Charge.	1.	2.	3.	4.	5.	6.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Pig-iron	50	nil	nil	nil	nil	nil
Scrap cast iron	44	nil	nil	nil	nil	nil
C.I. borings	nil	40	93.0	nil	55.5	38.5
Steel scrap	6	60	nil	nil	nil	58.0
Steel turnings	nil	nil	nil	90.2	40	nil
FeSi	nil	n.d.	4.3	7.2	3.5	3.0
FeMn	nil	n.d.	2.7	2.6	1.0	0.5
Coke	nil	4.5	1.3	4.0	3.0	5.8
Total metallic charge	100	100	100	100	100	100
Analysis of Cast Metal—						
C.	2.95	3.20	2.93	2.50	2.90	2.92
Si.	1.80	1.91	2.77	2.88	1.95	1.52
Mn.	0.40	0.71	1.42	1.11	0.85	0.65
S.	0.06	0.13	0.11	0.11	0.11	0.11
P.	0.60	0.17	0.43	0.11	0.27	0.19
Tensile strength, tons per sq. in.	19	24.0	21.8	25.7	21.2	24.3
Brinell hardness	235	232	255	273	248	238
Modulus of rupture, tons per sq. in.	n.d.	35.2	32.0	38.3	38.7	36.8

No. 1. "High-Test Grey Iron." Whiting Corporation.
No. 2-6. The Foundry Trade Journal, April 23, 1931. Dr. P. Bardenheuer.

Malleable Cast Iron.

Much more might be said on the subject of carbon in cast iron, as it is, after all, the most important element. However, this aspect of high-grade castings must be dismissed with a brief mention of malleable cast iron. For white-heart it is advantageous to get the carbon as low as possible consistent with the formation of white iron, since low carbon means saving in annealing time. Alternatively, with the same annealing time there is the greater certainty of production of high-quality castings with the requisite properties. In blackheart it is advisable to get the carbon as low as possible—even down to 2.0 per cent.—as its properties are mainly dependent on throwing out graphite in a very fine state of division. This is the last phase of carbon deposition, which was previously discussed, as there is solid graphite depositing from solid metal. The malleable properties are obtained from the soft iron base and the less graphite there is distributed about it, then the better are the castings. The rotary type furnace shows here a very great advantage over other types of foundry furnaces in being eminently suited for the manufacture of 2.0 per cent. carbon castings. The subject of carbon can be cut short by stating that even 0.2 per cent. carbon steels have been produced.

Influence of Elements.

While composition plays a most important part in the final properties, there are other factors which must be considered. Silicon and manganese are under control in rotary furnaces equally with any other type. There is a slight melting loss, so that the metal tapped is determined by the quantity charged. Phosphorus is unaltered, whilst sulphur may be said to remain constant. There is no direct contact with fuel and no direct pick-up. However, as the Brackelsberg furnace is similar to the open-hearth furnace, it can be said there is a tendency to pick up slightly with high-sulphur coal, and to lose slightly with low-sulphur coal. With average British coal of about 1 per cent. sulphur there is little change.

Another essential for high-grade castings is the production of sound metal free from gases and blowholes, whose presence considerably diminishes the strength of any casting. This problem of sound metal has been very carefully studied in steel manufacture, and it is well known that solid castings are produced from metal low in oxygen. Several very interesting theories have been suggested as to the mechanism of this freedom from blowholes, but a satisfactory explanation has yet to be put forward. However, it can be accepted as a practical proved fact that low oxygen means freedom from blowholes. There are two ways of making low oxygen metal: (1) by production of suitable slags and conditions inside the furnace so that the charge works continuously forward to a deoxidised state; (2) addition of deoxidising agents either in the bath just before tapping or in the ladle after tapping.

Commonly used deoxidising agents are ferro-silicon, ferro-manganese, aluminium or calcium silicide, which is the basis of the Meehanite process, etc. At the best this practice is simply doping inferior-made metal. It has limitations, particularly in the failure of the oxidised particles to disentangle themselves from the melt and rise to the surface. This is well known in the case of alumina. The correct way to produce deoxidised metal is to produce it in the furnace. It is known from physical chemistry that the quantity of oxygen in the metal is determined by the quantity of iron oxide in the slag under equilibrium conditions according to the partition law. With low-iron oxide in the slag there is low oxygen in the metal.

After melting in a rotary-type furnace, the metal is covered with a protecting layer of slag, which contains a quantity of iron oxide. Chemical reaction then takes place continuously in one direction, that is, reduction of iron oxide in the slag by the carbon, silicon and manganese in the metal. The lower iron oxide in the slag gives low oxygen in the metal, and dead-melted, gas-free castings are obtained. This continuous working towards the end point has an additional advantage in that it allows time for the particles of oxide to rise to, and be incorporated with the slag, an action which is further assisted by the steady rotation of the furnace allowing them to be disentangled. This idea of disentangling nuclei from the melt to produce high-grade castings is the basis of such processes as the jolting method of Dechesne and the suggestions of Hanemann.

The ease of control of the oxidising conditions in the atmosphere above the slag also acts advantageously in the Brackelsberg furnace. It has been clearly established by Whiteley that the FeO in the slag is oxidised by the gases to Fe_2O_3, which is again reduced by the metal to FeO. In this way the slag acts as a sort of carrier of oxygen from the gases to the metal. By having minimum oxidising conditions in the gases, and

large quantities of carbon in the metal, the second action predominates to such an extent that the carrying of oxygen is virtually eliminated. When it is realised that the iron oxide content of Brackelsberg slags is less than 3 per cent., the certainty of production of gas-free metal is assured.

The rotation of the furnace is a further important factor in producing homogeneous metal throughout the whole charge. The limitations of the cupola in this direction are too well known to require repetition. In making alloy castings, the low iron oxide content, the rotation, and the high temperature of the Brackelsberg furnace ensure complete and homogeneous incorporation of the special elements with minimum oxidation losses. The high temperature obtainable in the melt is again of importance, as it is the basis of such improvements as Emmel iron. The object here is to slow-off the cooling rate after casting with formation of a pearlite structure, giving greater resistance to shock stresses.

Advantages Summarised.

The advantages of the rotary-type furnace, such as the Brackelsberg, for the production of high-grade castings may be briefly summarised: (1) Low carbon content, giving fine graphite distribution with good tensile and shock properties with ease of machinability; (2) freedom from nuclei, giving fine graphite distribution and a small grain size, thus giving superior mechanical properties; (3) control of silicon, sulphur, phosphorus and manganese, giving any type of desired metal; (4) sound castings, giving superior mechanical properties and reducing wasters; (5) homogeneous metal, giving same composition throughout castings; (6) ease of adjusting composition of metal, if required, before casting; (7) hot metal, giving sufficient fluidity to cast very thin sections; (8) suited for manufacture of alloy cast irons, giving homogeneous metal with minimum oxidation losses of expensive alloying

TABLE III.—*Relative Melting Costs.*

	Cupola.	Brackelsberg.
	Shillings.	Shillings.
Charge—		
40 per cent. cast iron, at 75s.	30	30
60 per cent. scrap, at 45s...	27	27
Cost of 1 ton metal charged	57	57
Melting losses	6 per cent.	2 per cent.
1. Charge cost of 1 ton metal tapped	60.60	58.20
Melting Costs—		15 per cent. coal at 15s.
15 per cent. coke at 35s. ..	5.2	2.25
Lining ½ cwt. per ton at £2	1.0	1.0
Power, 6 k.w.h. at 1d. ..	0.5	12 k.w.h. at 1d. 1.0
Limestone, 2½ per cent. at 10s.	0.25	½ per cent. at 10s. 0.05
Labour (estimated) ..	2.0	2.0
2. Total melting costs ..	8.95	6.30
3. Interest and depreciation	0.60	5.00
4. Total smelting costs per ton of metal cast ..	70.15	69.50

elements, and (9) low carbon, fluid metal suitable for malleabilising by the white-heart or black-heart process.

While the above clearly indicates the advantages of rotary-type furnaces for quality in the manufacture of high-grade castings, it is only natural that industry is going to ask "What is the cost?" In order to gain an approximate idea of the cost, it will be convenient to make a comparison with the cupola. If it is possible to show costs comparable with cupola melting, then it can certainly be taken that the costs are very favourable compared with crucible smelting, air furnace, open-hearth furnaces, electric furnaces, or any system of duplexing or triplexing. Table III shows the relative costs for smelting in a cupola and in a Brackelsberg furnace.

From the table it can be seen that, using the same charge, allowing amply for interest and depreciation, and taking in melting costs, the Brackelsberg furnace and cupola costs are identical.

It has to be remembered, however, that in addition to producing better quality metal, the conditions of operation are such that cheaper material can be used in the charge. This is due to the higher temperature, thorough mixing and other causes already described. As a consequence, rotary-type furnaces can show a big saving in the first item, charge cost per ton of metal melted, which is obviously the one to tackle as it is the heaviest on cost. The Brackelsberg furnace will consume scrap only, which would show a saving of 15s. per ton over the cupola. Optionally, Dr. Bardenheuer has shown that excellent material can be produced from 100 per cent. borings or turnings and ferro-alloys, etc. This has been indicated earlier on. Here the saving is greater, as these can be bought to-day for about 30s. and the probable saving would be another 10s. on scrap figures.

It is impossible to deal with all such cases in this Paper, as each has to be tried out on its merits according to practice at individual plants. But probably enough has been said to show that rotary-type furnaces, such as the Brackelsberg, can produce at economic costs comparable with the cupola, even at a considerable saving on the cupola by using cheaper raw material. It shows economic advantages to the maker of high-test iron, the chilled roll manufacturer, or the producer of malleable castings. It produces high-quality castings with a regularity and consistency which is outside the possibilities of the cupola, and at a cost with which no other type of furnace producing high-quality metal can compete. There can be little doubt but that the near future will see an even greater application of the rotary-type furnace, because it fulfils that most desirable combination—production of the highest possible quality at the lowest possible cost.

Jobbing Foundry Work.

Mr. J. J. Feasey presided over a meeting of the Lincolnshire Section of the Institute of British Foundrymen at the Lincoln Technical School on December 5, 1931. The lecturer was MR. A. SUTCLIFFE, of Bolton, who said he intended to give a general talk on castings made on the jobbing foundry floor, illustrating by slides a number of practical jobs, all of which he had himself made. If he could pass on any helpful ideas and receive in turn some notions in the discussion he would be amply repaid. The jobbing foundry, he said, is the friend of everybody, and especially the engineer.

Mr. Sutcliffe showed a number of practical examples of particular interest to the jobbing foundryman. His first exhibit was a sample of his own mixture of facing sand for use on large castings. The only secret of this sand, he said, was that it was unmilled. Milled sand was the cause of many failures in large work. The only thing necessary was for the sand to be of a sufficiently fine texture for the work to be made, and he used several sieves of varying mesh size to obtain that degree of fineness. Some people, he said, liked to see a nice coloured skin, and went to expense in their sand-mixing preparations to obtain a blue colour. If colour was what was required it was only necessary to knock out the castings while they were hot, and the blue skin would be there when cool.

Core Binders.

Mr. Sutcliffe then detailed his mixture of oil sand. He used the "vegetable" oil, which gave him a green-bond when mixed with silica sand. The main advantage of this type of binder was that it air-dried to a certain extent, and could, therefore, be used in jobbing moulding without the necessity of drying. He showed lantern slides of several types of castings, having deep pockets of sand, that in ordinary green-sand moulding would be inclined to "scab." His method with this type of work was to cover the face of the pattern with the oil sand for a depth of 1 in., and then ram up the remainder with ordinary moulding sands. He always obtained a good clean job, and scabbing was eliminated. If one thought it advisable to dry the "cod" it would be essential to sprig at intervals of about 4 in., as there would be a risk of the oil sand separating from the moulding sand during drying. For splitting plates for pulley bosses and the like, Mr. Sutcliffe showed a cast-iron plate coated with oil sand. He thought this method to be far better than the old way of coating the plates with tar, clay wash and so on.

The lecturer illustrated some 50 jobs he had made, either from old castings or from existing tackle, at a minimum of expense in the pattern shop and foundry. He indicated many ingenious methods of practical interest, particularly in the manufacture of strickled-sand moulds to replace the rather costly methods of building up the moulds in loam.

DISCUSSION.

MR. J. FEASEY (the chairman) thanked Mr. Sutcliffe for his address, and said he was sure that the moulders present had received some very interesting and helpful hints. With regard to the hydraulic ram which had been shown, he had noticed this was run with the "flash" runner on the top edge of the feeder head. The casting had a feeder head of 10 in. depth of the same section as the casting. Did Mr. Sutcliffe find that head sufficient to feed the casting, as with the use of the flash runner there appeared to be no method of feeding other than the "header"?

MR. SUTCLIFFE replied that he never trusted to the header to feed that type of casting. When using the flash runner he made provision for the feeding rod in one place. This hole was covered with a stopper during pouring, and then lifted away and the casting fed in the ordinary way.

MR. MATHER asked for the author's views on the use of what he had termed "vegetable" oils, as against the oils of the thin type that were marketed by many firms.

MR. SUTCLIFFE said that by vegetable oils he meant the stiff "toffee" type of binder. If Mr. Mather was interested he could tell him his own mixture of that type of binder. For jobbing work that was the only type of oil sand he used, as it gave him the green bond, and also it dried partially when exposed to air. The linseed type of binders had but little bond in the green state. They were satisfactory for some cores, the bond being acquired in the stove.

MR. COLEMAN thanked Mr. Sutcliffe for a very practical address. He thought the remarks on strickled-sand moulds should be of particular interest. That type of moulding was not generally known in the Lincolnshire district, and he thought it a method that might very well be employed in some of their own jobbing work.

Indian Pig-iron in Japan.—Since the cancellation of the agreement between the Japanese Pig-iron Guild and the Steel Material Purchase Guild, the importation of pig-iron into Japan has been much on the increase, reaching 13,000 tons in July, 18,000 tons in August and 16,000 tons in September. The import price declined by 3 yen some time ago and now rules at 24 odd yen partly in sympathy with the rupee. This price is equivalent to 33 rupees (£2 9s. 6d.) which is about one-half of that ruling in India, from which it is evident that the Indians are dumping the iron. This year's total imports of pig-iron into Japan will probably reach more than 120,000 tons.

XUM

Modern Applications of Sand-Blast Plant.*

By T. Fearnley Allen.

In introducing the subject of sand-blast plant to an audience of foundrymen it seems desirable to concentrate more on the many uses to which it can be put and the special conditions governing the efficient application than on details of individual machines, but it is advisable first to enumerate the different types of plant, as the selection of that most suitable for any special purpose is an important factor in the ultimate efficiency. In all cases, unless specifically stated to the contrary, the direct pressure system, as opposed to the suction or gravity system, is the one generally referred to.

Pressure Apparatus.

This in some form or other is common to all types as it forms the sand-blast unit proper. The abrasive is under pressure from above, whilst the main stream of air passing along the mixing pipe carries a full volume of abrasive to the hose-pipe and from there to the nozzle. These apparati when working in conjunction with a machine are made with a double chamber, either semi or wholly automatic, thus ensuring a continuous flow of abrasive, but when in use with a room or cabinet they are usually of the plain single-chamber type as the process of recharging the abrasive is only a matter of from 2 to 3 min. and this is usually done when the operator is changing the work.

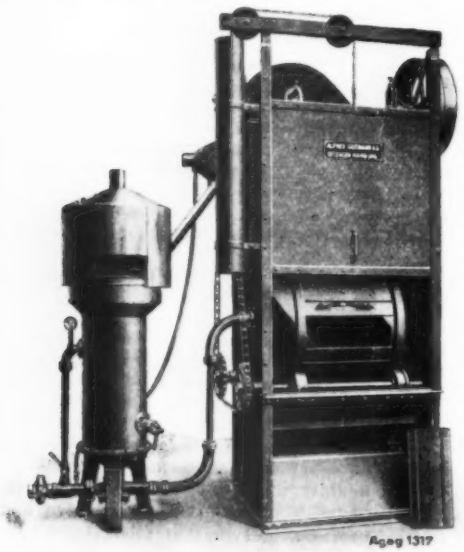


Fig. 1.—Rotary-Barrel Sand-Blast Plant.

Rotary Barrel.

Here the work is fed into a barrel which revolves about 2 r.p.m.; it is left in for from 10 to 30 min. according to the class of work and the finish required. The barrel itself, as shown in Fig. 1, is contained within an outer steel structure and revolves on four rollers, two of which are driving. The used abrasive falls through perforations in the barrel shell to a hopper from where it is taken either by means of a bucket elevator to a dust separator, or through a suction pipe to a cyclone. The usable abrasive returns automatically to the apparatus and the dust by means of a fan is drawn away to the exhaust duct.

The nozzles are as a rule fixed one on each side of the centre line of the barrel, and as the barrel revolves all the surfaces of the work are brought under the blast. An interesting development is one styled the "Tum Blast," where, instead of the work revolving in a barrel casing, it is carried on an endless chain conveyor, thus passing continuously under the blast nozzles; for emptying the work the motion of the belt is reversed. This type is particularly useful for heavy forgings and castings.

Rotary Table.

Here the work is placed on the table, which, according to the finish and output required, makes one revolution in from 2 to 5 min. Across the centre of the table are one or more rows of rubber curtains which assist in keeping the abrasive from flying outside. Behind the curtains are the nozzles, which, according to the make of plant, are either of the oscillating or rotating type and are usually two in number. In the type shown in Fig. 2 it will be seen that the apparatus itself is built on to the machine, thus dispensing with all blast-conveying pipes and hoses and ensuring an even flow of abrasive, a point which is very important in this type of plant as it will be seen that if any part of a casting did not receive efficient sand-blasting it would have to remain on the table for another revolution, especially when being prepared for enamelling. A further development is a machine similar in general respects but having four nozzles inclined to the work; by this means the edges and corners of castings can be thoroughly blasted.

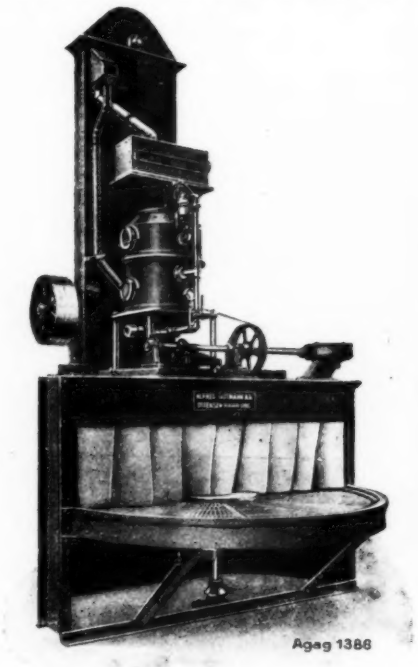


Fig. 2.—Rotary-Table Sand-Blast Plant.

Reciprocating or Conveyor Type Table.

This can be adapted for a very large variety of work, the table or conveyor being designed for the special class of work to be dealt with. The tables have forward and reverse motion, and are sometimes built in two halves, running in opposite directions. The blast nozzles are arranged so as to blast from above, below or from the sides as required, and have a rotary or oscillating motion, according to the class of work. In the case of conveyors, these are either in one continuous length or, when the blasting is done from the under side, the belt is built up in two sections.

Room.

This type of plant, which comes under the heading of "free blast," is perhaps the one most generally in use; at the same time, it is far from being hygienic, as even with the very best system of exhaust it is impossible for the work to be done without dust being produced. In spite of helmets and air filters, the operator is working under very unpleasant conditions, and, with the present stringent Home Office regulations, this question of dust has assumed great importance, and it is imperative that the fullest attention be paid both to the method adopted for drawing off the dust and to its ultimate disposal.

In calculating the capacity of the exhaust fan, allowance should be made to turn over the air in the room from five to ten times per min.; this is governed by the amount of dust created in the room and the working pressure of the air. The method of exhausting the dust-laden air varies; some plants use the up-draft system, others the down draft. In either case full allowance should be made for the admission of fresh air. As to the final method of settling the dust, this can be done by various means, which will be dealt with later. A further point is that the flooring should be of either the open steel strip type, or cast-iron gratings; by their use the accumulation of dust on the floor is avoided.

Cabinet.

This type of plant can be made very adaptable, and, when dealing with light- or medium-weight castings, has many advantages over a room. The operator working outside is free from all dust, and if the cabinet is fitted with a hinged and lifting front, it is possible to deal with relatively large castings. The operator works through a rubber screen, and has a sight screen through which he has a full view of the work. If a small turntable is also fitted inside the cabinet, one is enabled to deal with quite intricate castings without any handling whatsoever.

The initial cost is naturally appreciably less than a room, being much smaller in area; also, this fact reduces the capacity of the fan required, and consequently the horse-power necessary; further, no foundations are required. Another type of cabinet in common use is a

* A Paper read before the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, Mr. F. J. Hemming presiding.

plain vertical one, which is used for dealing with gears, tools and other small details.

Consumption of Air.

This item, which in the ordinary cleaning of grey-iron castings, with a working pressure of 30 lbs. per sq. in., represents about 35 per cent. of the total running costs, needs careful consideration. The tendency in this country is rather to look at the total cost of horse-power than to take the basis as horse-power per unit of area sand-blasted. This is altogether opposed to the American point of view, where high-working pressures, even for the ordinary cleaning of castings, are the rule, not the exception. Naturally the basis cost of the power unit is the important factor, as is also the ultimate output required, but the final efficiency of the plant is largely governed by full consideration being given to these points.

If it is required to retain the skin on a light casting, the pressure must be kept low; 18 to 25 lbs. will clean off any foundry sand without cutting into the metal. Heavy castings should be dealt with at a pressure of from 30 to 45 lbs., and steel castings and stampings from 45 to 60 lbs.

High pressures of from 60 to 80 lbs. per sq. in. are ordinarily used for treating castings preparatory to vitreous enamelling. Care must be taken when delivering air to the sand-blast unit to see that it is free from oil and moisture, otherwise choking up of the abrasive is bound to occur. An oil and water separator should be embodied in the compressor, or fixed separately in the air pipe line and placed as near as possible to the sand-blast unit.

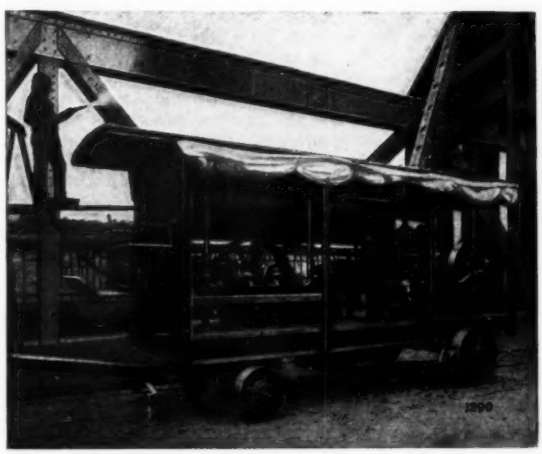


FIG. 3.—TRANSPORTABLE SAND-BLAST PLANT FOR CLEANING GIRDERS AND SIMILAR WORK.

Exhaust System.

The increase in the use of sand-blast methods has directed the attention of both the Home Office Authorities and users to the necessity for adequate means to suppress the dust and so improve the working conditions for the operator. The two main points to be studied are:—(1) The removal of the dust from the proximity of the operator as quickly as possible and (2) the ultimate disposal of the dust outside the building.

As regards the former, there should not be much difficulty, provided that the capacity of the exhaust fan and the area of the piping are correctly calculated. For the disposal of the dust, however, there are various methods in practice, such as water tanks and closed catch boxes, which, whilst reducing the dust, cannot possibly be considered to be as fully efficient as the better-known methods. The passing of the dust through a water spray and later through a bed of moistened coke does eliminate the greater portion of the dust, though owing to the dust, especially in the case of sand and flint, having very little affinity for water, the tendency is for it to follow the main air stream; it also has the objection that the residue, namely, sludge, has to be emptied out periodically, and this operation is both expensive and unsatisfactory.

The use of some type of cyclone is very common, and whilst this is in some respects an improvement over the wet system, as the residue is in the dry state, yet it cannot be considered wholly efficient, as the fine dust given off by sand-blasting has a very low-specific gravity, and the centrifugal force has very little effect on it, and, consequently, quite an appreciable amount of the dust gets carried away by the free-air discharge instead of falling into the hopper below the cyclone. The most satisfactory system is the bag- or screen-type filter; here the dust-ladened air is filtered through a cloth which, being of a fine texture, retains the dust whilst allowing the air to pass through. They are worked on either the pressure or suction system, the selection being governed by the class of dust to be treated, as it is inadvisable to pass any through the fan which is likely seriously to affect the wearing parts. For normal-sized plants it is not necessary to fit any special shaking device, but in the case of large plants or where they are likely to be in continuous service, either a shaking device is fitted or the current of air is reversed, thus causing the dust to fall into a hopper, from which it is removed at will.

Abrasives.

Sand and flint are usually employed in cleaning sheet-metal work and non-ferrous castings when the finish required is to be a matt surface, also on many iron castings when the special grey finish is required. Sand, owing to its lightness, does not damage the surface of soft metals and also gives a greater scouring action. Sand and flint are also more generally used when the work is to be plated or painted.

Steel has replaced sand to a very large extent, due largely to the Silicosis Regulations. Steel shot is, in its finer grades, extensively used for cleaning cast iron, brass castings, cycle frames, hardened machine tools, *i.e.*, drills, taps, etc., hardened gears and shafts and even for matting aluminium crank cases, gear boxes, etc. Steel angular grit is more generally used where a heavy cutting action is required. The sharp edges of the grit open up the pores of the metal. This abrasive is the most suitable for heavy cast-iron castings, steel castings, removing scale from steel stampings, sectional work, etc. It is also used for preparing cast-iron castings prior to vitreous enamelling. The surface is opened and gives "legs" as a bond to the enamel.

In general, steel abrasives are usually employed if at all possible. Steel abrasive, however, owing to the increase of weight over sand, requires a higher working air-pressure to keep a uniform and full volume of abrasive flowing.

Applications of Sand-Blasting to General Castings.

Small castings, non-ferrous, grey-iron, malleable, steel castings and stampings should be cleaned whenever possible in a barrel. A barrel 32 in. dia. by 40 in. long, fitted with two $\frac{3}{8}$-in. dia. nozzles and working at 30 lbs. per sq. in. pressure would clean 20 to 30 cwt. of grey-iron castings per hr. This machine only requires unskilled labour and is a very cheap method of sand-blasting. The loading time of the barrel is an important factor and mechanical loading will increase the output of a barrel by possibly 20 per cent.

Larger or more delicate work, especially flat work, *i.e.*, stove parts, electrical switch-gear parts, junction boxes and general castings (up to about 56 lbs. weight) should be dealt with on a rotary table machine. A very large output can be obtained on this type of machine. On a table 7 ft. 3 in. dia. fitted with two $\frac{3}{8}$-in. dia. rotating nozzles and a working pressure of from 25 to 30 lbs. per sq. in., 30 to 40 cwt. per hr. of light grey-iron castings can be cleaned. When dealing with castings preparatory to vitreous enamelling, it is usually necessary thoroughly to clean the sides and edges and to obtain an even finish. The best type of machine is one fitted with inclined rotary nozzles. With a table of 9 ft. 2 in. dia. and four $\frac{5}{16}$-in. dia. nozzles, working at 60 lbs. per sq. in. pressure, an output of 6 to 7 cwt. per hr. is reached. When using these machines special attention should be given to the packing of the table, otherwise if spaces are left between the castings the abrasive will cut away the table grids and structure of the machine, causing unnecessary wear and tear.

Castings which can be readily handled by an operator are effectively cleaned in a cabinet plant, and if a turntable is fitted handling is reduced to a minimum. Cabinets can also be fitted with conveyors to and from them, still further reducing handling times.

Heavy castings and the general run of steel castings are sand-blasted in rooms. There are many modifications in the room-type plants which make for speedy handling. A standard room-type plant without trolley or conveyor is usually only working half to two-thirds of the day, the rest of the time being taken up in loading and unloading. A simple turntable will often speed up production; this would be placed generally in the centre of the room and loaded up with work. A trolley can well be used in conjunction with the table.

One of the best modifications is the half in and half out table. The sand-blaster is working on the half which is inside the room, while the work which has been cleaned is then turned through 180 deg. and is removed. Meanwhile, a further load has been placed on the half outside the room, and this is brought in front of the operator. This type of room is practically continuous in operation. Another type is the monorail for handling such articles as piano frames, sluice gates, textile-machinery parts, etc. The casting is slung and run into the room and cleaned; all handling of the next job is done outside the room while the sand-blaster is working. A double track or points allow for the exchange of the work.

A conveyor may also be utilised where a time cycle is to be adhered to. Cylinder blocks, axle cases, etc., may be passed straight through the sand-blast room from the foundry to the dressing shop.

Gears, Tools and Hardened Small Parts.

The type of plant usually adopted is a small vertical cabinet, the operator working through arm-holes. But in the case of drills, taps, dies, etc., it has been found that the rotary barrel is the most efficient. Large quantities can be effectively cleaned with no damage to the sharp edges. A thousand $1\frac{1}{2}$-in. taper drills can be sand-blasted in 40 min., this in a barrel 24 in. dia. by 20 in. long. Small gears and machine-tool parts, also hardened motor and cycle parts, *i.e.*,

ball races, locking nuts, pins, collars, washers, etc., are most suitably dealt with in this type of machine. For cleaning the larger sizes of gears a rotary table or cabinet would be employed.

Scaling of Sectional Steel Billets, Plates, Tubes, etc.

This class of work usually calls for a specially-designed machine, except in cases where only a small output is required, when an ordinary free blast nozzle is sufficient either in conjunction with or without a room. The general principle governing the design of a machine capable of dealing with a large output is to convey the material by means of a sprocket table or belt conveyor through a closed cabinet in which the nozzles are placed in such a position that all edges or surfaces of the work are blasted at one and the same time. By this method the maximum output is obtained. The usual rate of travel varies from 5 to 7 ft. per min., but speeds up to 11 ft. per min. are possible. The usual working pressure is from 30 to 45 lbs. per sq. in., the governing factor being the hardness of the scale to be removed and the rate of feed required. In the case of plates, these are usually passed through the machine in the vertical sense, when they can be blasted on one or both sides.

Railway Carriages and Wagons.

In dealing with actual vehicles it is customary to erect a special room into which they are run on rails. The sand-blasting is carried out by means of the ordinary free blast; the abrasive falls through the floor as in the case of an ordinary room and is then conveyed to the dust separator. The dust in suspense is drawn away through a special system of hoods to the main exhaust piping. This system has many advantages over the ordinary method of preparing vehicles for repainting; it ensures that all the old paint or varnish is removed and leaves a surface particularly suitable for the new paint. The actual time saved by sand-blasting over the ordinary hand methods is approximately 70 per cent., and in cost between 35 and 50 per cent. The same treatment is often applied to motor-car bodies and chassis, also locomotive tenders.

Locomotive Boilers.

The removal by hand of scale inside the barrels of boilers is recognised as being both an unpleasant and tedious method, and the adoption of sand-blasting is a considerable improvement. After the tubes have been removed, a runner bar is placed between the firebox and smokebox tube plates, and on this is carried the nozzles, which have both a rotary or oscillating and forward travelling motion, the drive being obtained through a mechanical unit outside the boiler. The operator sets the nozzle at the firebox end, and, coming out of the boiler, starts the motor, the nozzle then travels the length of the boiler, when it is cut off. The longitudinal feed is about 1¼ in. per min. By this method the work is done in about one-sixth of the usual time employed, and with the certainty that the scale is removed round all rivet heads and the joints of the plates, thus leaving a surface which lends itself to perfect inspection. The dust in suspense is drawn away through piping, and the scale is swept up and emptied through one of the manholes. It will be noted that the operator is not in contact with any dust whatsoever. The tubes can be cleaned by being passed through a tube-cleaning machine, one or more nozzles being fitted.

Iron Structures.

Bridges, steel girders, gas and acid tanks and similar work can be effectively cleaned, all rust and old paint removed, thereby exposing any defects in the plates or rivets. A transportable plant, shown in Fig. 3, would be used, comprising a petrol unit or electric motor, air compressor and receiver and a sand-blast apparatus. The usual working pressure can be taken as 30 lbs. per sq. in. A special design of plant has been produced for dealing with round tanks, where a set of nozzles, both inside and outside the tank, is operated automatically. A similar plant would be used for buildings and masonry, though the air pressure would be lower, namely, from 15 to 20 lbs. The cleaning of ships' hulls can well be done by sand-blasting, and either a transportable plant would be used or the air taken from an existing air main, such as would be found in most dry docks.

Glass Industry.

This branch of industry is catered for very well. Many types of special machines are utilised for speeding up the production of glass articles which are to be dealt with. The sand-blasting of glass in its simplest form is done by the suction system at low pressure, 2 to 5 lbs. per sq. in., the object being to scour the glass, leaving a frosted surface or to prepare it to receive enamel, *i.e.*, badging bottles, tumblers, etc. Where a stronger cutting action is required, when piercing holes or making glass signs, a higher pressure, 7 to 15 lbs. per sq. in., is employed, and the direct-pressure system may advantageously be used.

The vacuum system is used for machines dealing with large outputs of globes, lamps and shades. These are placed in the machine and are frosted with the required design; about 120 to 150 pieces, 6 in. dia., may be prepared per hour. The same system is employed when dealing with plate glass. The sheets are fed through the machine by rubber rollers at the rate of about 80 ft. per hr. These types of machines are under vacuum, and, consequently, dust is not developed in the shop. The dust-laden air is sucked through a sand separator, then through the air purifier, so that only clean air passes through the blower, which may exhaust back into the shop. Steam pressure may be utilised; machines employing this power are capable of giving a very soft finish, a steam pressure of 55 to 70 lbs. per sq. in. being used.

Scouring and Sharpening Files.

Steam pressure of 60 to 75 lbs. per sq. in. is exclusively used for this purpose, and the machines work under the suction system. The abrasive is a fine sand made into the form of slime. Machines are fitted with one, two or three nozzles, according to the output required. The blast is directed at a certain angle against the back of the teeth of the file. A machine fitted with a 2-in. slit nozzle would handle 1 to 3 dozen files per hr. with a steam consumption of 160 to 200 lbs. per hr.

Testing of Materials.

By means of sand-blast, worked either by air or steam, an extremely simple method of testing stone, wood or composition required for street paving or flooring has been adopted. Usually in order to obtain any particulars as to the value of any certain material, a trial extending over months or years was considered necessary, but by adopting a machine designed for the purpose a reasonable test can be made at once. The material is cut into cube form of about 2⅜ in. and these faces are exposed to a blast of about 45 lbs. per sq. in. for the space of 2 min., and thus comparisons can be made as to the qualities of the different samples.

There are many other classes of work which can be quickly and efficiently done by sand-blasting, such as celluloid articles, jewellery, buttons, lamps, ornamental work of gold or silver, woodwork and pottery, all of which could be dealt with in one or other of the standard designs. In fact, the uses to which sand-blasting can be put are far in excess of what is generally considered possible.

It is impossible within the range of a single Paper to cover fully the many variable factors that require to be taken into consideration when selecting a new plant, and, perhaps, it may be of help towards a better understanding if the principal items are enumerated:—(1) Material, whether steel, cast iron or non-ferrous; (2) finish required, whether simply cleaned or prepared for metallising or enamelling; (3) shape and size of article; (4) output required; (5) air pressure to be used; (6) class of abrasive; (7) unit cost of current; and (8) handling facilities.

It will, therefore, be seen that to strike a true balance between the many factors involved needs very careful consideration, and this forms the essence of sand-blasting problems.

Book Review.

Stainless Iron and Steel, by J. H. G. Moneypenny, F.Inst.P. Second Edition. Published by Messrs. Chapman & Hall, Limited, 11, Henrietta Street, London, W.C.2. Price 25s. net.

The outstanding compliment that we can pay to this book is that the first edition was absorbed in less than a couple of years, which is very unusual for a work of a metallurgical character. We believe its success is entirely due to the fact that it deals with one subject only. The old-fashioned author would have written a book on alloy steels and compiled everything outside his personal experience, which meant that most technical books carried a vast amount of padding. Although this work now runs to a matter of 575 pages every bit is germane to the subject covered by its title. Amongst the improvements noted are the bringing of the book right up to date, the use of better paper for carrying the photomicrographs, and an infinitely better index. Our readers can regard this as the standard work of reference on the subject of heat- and corrosion-resisting steels.

Patent Specifications Accepted.

The following list of Patent Specifications accepted has been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The last numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

9,824. Brown Bayley's Steel Works, Limited, and Bull, H. Alloy steels. 858,063.

10,083. Vereinigte Stahlwerke Akt.-Ges. Iron railway sleepers. 357,995.

15,666. Wellman Smith Owen Engineering Corporation, Limited, and Webb, A. Ogilvy. Method of, and means for, the heat-treatment of metals. 357,575.

18,734. Fahrlander, E. Salt bath for annealing metal articles. 357,538.

30,589. Clarke, H. W., and Aitchison, L. Aluminium alloys. 357,805.

35,015. Ford Motor Company, Limited. Method of, and a machine for, casting and forging. 357,855.

Chemical Standardisation.—As already announced, the British Engineering Standards Association has now been re-organised to permit of it dealing with standardisation questions in the chemical and other industries, these groups or divisions of industry being controlled by representative divisional Councils of equal standing. A supplemental Royal Charter has been granted to the Association authorising this re-organisation and changing its title to the "British Standards Institution." For the first time the Chemical and Allied Industries are now possessors of the proper machinery for setting up national standards for chemical materials, plant and apparatus, and for methods of analysis and testing. Every British firm and every individual chemist in these industries is eligible to become a member of the Institution at a nominal fee. Membership carries with it certain valuable privileges and advantages, and it is hoped that all manufacturers and others in the chemical industry will co-operate in this work and assist the Chemical Division of the Institution by becoming subscribing members.

This Week's News in Brief.

Trade Talk.

MESSRS. BRADSTEADS, LIMITED, Bilston, have recently secured substantial orders, and are extending their foundry.

MESSRS. ROBERT HUDSON, LIMITED, Gildersome Foundry, Leeds, have removed their London office from Suffolk House, Cannon Street, E.C., to 21, Tothill Street, Westminster, S.W.1.

MESSRS. ASHALL BROS., Chester Road, Cornbrook, Manchester, have given up their gear-cutting department, having transferred the business in this department, together with a portion of their plant, to Messrs. Barlow & Chidlaw, Limited, Pendleton, Manchester.

MESSRS. JOSEPH EVANS & SONS (WOLVERHAMPTON), LIMITED, have received a contract from the Russian Government for heavy pumping machinery for use in the Russian mines and on the railways. A smaller order for pumping plant was received a short time ago.

DURING THIS YEAR Messrs. Vickers-Armstrongs, Limited, have launched new shipbuilding tonnage to the extent of 77,208, as compared with 19,307 tons in 1930. The horse-power constructed this year was 231,700, as against 110,100 last year. Of the total launched, the Barrow yard constructed 54,406 tons, and Walker-on-Tyne 22,800 tons.

AN ORDER has been placed with Messrs. Beyer, Peacock & Company, Limited, by the Great Northern of Ireland Railway for five three-cylinder, compound, express passenger locomotives with a 4-4-0 wheel arrangement. Another order recently received by the company is for a "Beyer-Garratt" locomotive for the Sneyd Collieries, Limited, Burslem.

A CONTRACT ESTIMATED AT £500,000 has been placed with Messrs. Sir Robert McAlpine & Sons by the London & North Eastern Railway Company. It comprises widening the railway from Gidea Park to Shenfield, a distance of seven miles, which will entail the construction of two retaining walls, each over a mile long, burrowing a junction under the Colchester main line for the Southend down line, the reconstruction of fifteen bridges and approximately 500,000 cub. yds. of excavation. The work is to begin immediately, and will be completed within two years.

IT WAS REPORTED at the last meeting of the Metropolitan Water Board that the Works and Stores Committee, who had been considering the bursting of water mains in London, were impressed with the necessity for visits of inspection to the works of various contractors engaged in the manufacture for the Board of cast-iron and steel pipes, and that for the purpose of supplementing inspections made by the Board's staff they had secured the services of an inspector who had from time to time made tests at the contractors' works. It was recommended that this inspector's services should be engaged for a definite period of three months for this purpose, and to this course the Board agreed.

THE STATUTORY annual general meeting of the Association for the Promotion of Co-operation between Scientific and Technical Societies and Institutions within the British Empire was held in London on December 1, Sir David Milne-Watson (chairman of the Council of Management) presiding. The report referred to the appeal for a central building in London issued in February, 1931, to the members of the constituent societies and institutions, in which it was stated that options had been secured for a limited period on a site near Westminster Abbey, and that an estimated sum of £350,000 would be required to defray the cost of the complete building, including the purchase of leases, etc. It was further mentioned that to complete the purchase of the leases, it would be necessary to secure £100,000 in cash by June 24, 1931, when the options on the site would expire. A considerable response to the appeal had been received. The sum available by June 24, however, fell considerably short of the amount required in cash, and, after consideration of all the circumstances, the Council of Management had decided to allow the options on the leases to lapse. The acute financial and industrial conditions prevailing during the year, culminating in the recent crisis, had rendered it necessary for the Council to postpone a public appeal until national conditions improved.

Personal.

MR. BERNARD HUET, of Vivier-au-Court, has been elected President of the Ardennes Foundry Association in the place of the late Mr. Martin. Mr. René Lebean, of Revin, is now Vice-President.

MR. B. G. HEELEY and Mr. C. L. Price have been elected directors of Messrs. Kayser, Ellison & Company, Limited, Carlisle Works, Sheffield. Mr. Heeley has been with the firm for more than 40 years, and Mr. Price more than 20 years.

CONGRATULATIONS are due to Mr. A. le Thomas, who is prominent in international foundry circles on account of his many contributions to the study of the testing of cast iron, on the receipt of an award made triennially by the French Institution of Civil Engineers for the best metallurgical Paper presented during that period.

Wills.

AVELING, T. L., late managing director of Messrs. Aveling & Porter, Limited, engineers, Rochester	£65,677
CLARKE, A. G. C., a director of Messrs. G. A. Harvey & Company (London), Limited	£18,136
BAINBRIDGE, W. A., of Messrs. A. Bainbridge, Limited, North Yorkshire Ironworks, Thornaby-on-Tees ...	£11,457

Contracts Open.

Ayr, December 21.—17,800 ft. of 21 in. dia. bitumen-lined lap-welded steel pipes, with bitumen-lined steel specials and cast-iron specials, for the Corporation. Messrs. Warren & Stuart, 94, Hope Street, Glasgow. (Fee £2 2s., returnable.)

Blackburn, January 9.—Iron and steel stores, for the Corporation. Mr. H. M. Webb, borough and water engineer.

Cairo, February 18.—Waterworks equipment (pumps, etc.), for the Egyptian Ministry of the Interior. The Department of Overseas Trade. (Reference G.X. 10,962.)

Lincoln, December 22.—87,250 yds. of cast-iron pipes, 7 in. to 2 in. dia., and specials, for North Kesteven Rural District Council. Messrs. Elliott & Brown, Burton Buildings, Parliament Street, Nottingham. (Fee £3 3s., returnable.)

London, N., January 15.—Iron and steel stores, for the Islington Borough Council. The Town Clerk.

Saffron Walden, December 23.—6,700 yds. of cast-iron or spun-iron pipe mains, 3 in. to 8 in. dia., with all fittings; Diesel oil engine, overhead gear and centrifugal pump, two sets small electric pumps, with automatic control, Venturi meter, etc.; complete base exchange water-softening plant, softening 134,000 gallons of water to zero between regenerations, for the Town Council. Mr. A. H. Forbes, Council Offices, Hill Street. (Fee £2 2s., returnable.)

New Companies.

Alfred Ellison, Limited, Black Lane Ironworks, West Bromwich.—Capital, £8,000. Iron, steel and metal founders. Director: A. Ellison.

Arda Metal Company, Limited, White Cross Metal Works, East Street, Coventry.—Capital, £1,000. Directors: G. S. James and A. E. Ryder.

D. Douglas Stewart & Company, Limited.—Capital, £2,000. Machinery and metal merchants. Director: H. G. Ashby, 24, Trafalgar Place, Swansea.

At the moment of going to press, we learn of the death of Mr. W. G. Hollinworth, who from 1918 to 1926 was secretary of the Institute of British Foundrymen. On behalf of the foundry industry, we offer to his widow and daughter our sincerest sympathy. An appreciation of Mr. Hollinworth's activities will appear next week.

The Eighth Annual Refractories Ball will be held on January 8 next at the Royal Victoria Hotel, Sheffield. Dinner (15s., exclusive of wines) will be served in the Ballroom, and tables will be reserved in strict rotation of applications received, which must be made before January 1, to Stanley Brooke, Oughtibridge Silica Firebrick Company, Limited, Oughtibridge, near Sheffield.

Copper Crisis Continues.

BY "ONLOOKER."

The news that the Phelps Dodge Copper Corporation, third most powerful member, as regards output, of the Incorporated Copper Exporters, had given notice of withdrawal from the Association was not altogether a surprise to the market, which had daily been expecting evidence that the disruption of the exporters was at hand. The immediate effect, however, was further heavy liquidation of standard copper, which fell to £33 for the three months' position, while wire bars were marked down to £40, although the sterling equivalent of the Cartel price was about £44 on an exchange parity of $3.58. Outside offers were made during the same afternoon at £40 5s., and there was every indication that a further slump was imminent.

On second 'Change, however, values of standard copper rallied, for there were rumours that Katanga had abandoned its independent attitude and was prepared to curtail to the extent asked for at the conference. The following morning found the rumours resolved into an authentic report of the Belgian concern's willingness to co-operate in scaling down output, and, in spite of fears that the fate of the exporters hung in the balance, the London market gave an emphatic demonstration of optimism, although values failed to hold the best points on account of heavy selling at the close, which was presumed to be on American account.

Rumour has followed rumour, and among these may be cited the report that Katanga's concurrence in curtailment was not so certain as at first announced. Well-informed opinion in copper circles, however, gave this suggestion little credence; nor was there much heed given to a hint that trouble might arise with the Canadians. On the question of the attitude to be adopted by Phelps Dodge, opinion was divided, but the majority inclined to the belief that the prospect of all-round curtailment would persuade these producers to re-enter the fold. Latterly the copper situation has altered with lightning rapidity.

At the time of writing, it is impossible to say whether the Association is going to survive the immediate crisis or not, but the odds seem to be in favour of its continuance. Students of the market situation are, however, doubtful whether a tiding-over of present difficulties can be more than temporary, and there is an inclination to believe that within the next few months the end will come. Were we on the eve of a considerable trade revival promising a largely increased use of the red metal, the outlook would be more promising, but copper is passing into consumption so slowly that only the most drastic form of curtailment will suffice to correct the situation. So large are the existing stocks that complete cessation of production for six months is really indicated, but that, of course, cannot be expected, nor on the whole would it be desirable. There is quite a considerable body of opinion which holds the view that, matters having reached such a pass, it would be better for all concerned were copper exporters to break up, and let free and open trading take the place of a set of rules and regulations which have proved both cumbersome and embarrassing to users of the metal.

The effect of the depreciation of sterling, which is keeping the quotation for refined copper above £40, tends to forgetfulness of the fact that present values are impossibly low, and for this very reason it seems fair to argue that a modest recovery on improved sentiment alone is to be expected. The somewhat extraordinary thing is that nobody wants copper at its present low level; the producers certainly do not, and consumers are quite prepared to pay the proverbial "sixpence a pound" if only stability could be assured.

Raw Material Markets.

Throughout the iron and steel markets in the past week there has been a noticeable lull in business. Buyers seem to be refraining from buying, so as to have as small a carry-over of stocks into the New Year as possible. The slackness of buying is, however, believed to be only temporary, and a revival of the more active trade of recent weeks is expected early in January. These conditions apply to most of the raw material markets.

Pig-Iron.

MIDDLESBROUGH.—Although the tone of the market is good, there is a temporary pause in business. Consumers generally are trying to avoid a heavy carry-over of stocks into the New Year, and in consequence they are confining their purchases to small parcels for immediate delivery. It is therefore expected that stocks will need replenishment early in January. However, the home position of the producers is fairly good, although export difficulties do not decrease. All the advantages of the depreciation of sterling are offset by tariff barriers, import restrictions and exchange fluctuations. Prices remain as follow:—No. 3 Cleveland G.M.B., 58s. 6d.; No. 1 foundry, 61s.; No. 4 foundry, 57s. 6d.; No. 4 forge iron, 57s. per ton.

In the East Coast hematite market stocks are being reduced at a satisfactory rate, and, although sales are not brisk at the moment, steady deliveries are being made against contracts. There cannot be much longer delay in the fixing of further contracts, and then the question of expansion will arise, for there are still only four blast furnaces producing hematite on the East Coast. Prices are firm, and East Coast mixed numbers are steady at 65s. per ton.

LANCASHIRE.—Business is now more quiet, and is expected to remain so until the beginning of the New Year. It is evident from the disappointing amount of business going to the Scottish makers that they are still feeling the effects of the competition of cheaper Indian iron. Quotations are maintained, with Midland foundry makes on offer for delivery to users in the Manchester price zone at 67s. per ton, North-East Coast at 67s., Northamptonshire at 65s. 6d., Derbyshire forge iron at 62s., Scottish pig-iron at about 87s. and West Coast hematite at about 81s.

MIDLANDS.—Deliveries of pig-iron are still being taken at a good rate, most of the iron being destined for the light-castings trade. Prices remain unchanged. For delivery to Birmingham and Black Country stations, makers continue to quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—Less and less business is being done as the end of the year approaches. It is hoped, however, that there will be a revival of buying in the New Year. Scottish No. 3 foundry iron remains at 69s. 6d. f.o.t. furnaces, with 2s. 6d. extra for No. 1, and Cleveland No. 3 continues at 61s. 6d. at Grangemouth.

Coke.

The coke market is quiet. The consumption of blast-furnace coke is limited. There is a moderate demand for patent-oven coke for export, and gas coke remains very firm. Furnace coke is quoted at 16s. 9d., delivered Middlesbrough, and foundry coke for export is being sold at 17s. 3d., f.o.b. Newcastle.

Steel.

There is still room for a great deal of improvement in the finished-steel market, although conditions are slightly better than they were last week. The lighter trades are in a better position, but the sheet trade is unchanged. A good share of the orders for semis is still going to home works, but, with smaller exchange fluctuations, it is probable that there will be an expansion of Continental buying.

Scrap.

In the Cleveland iron and steel scrap market the demand has once again declined. Consumers seem to have fully satisfied their needs. However, it is expected that there will soon be a resumption of buying, and there is no tendency to press sales at cut prices. Heavy steel scrap finds a very limited sale at 42s. 6d. per ton, delivered works. Machinery cast iron is quoted at 47s. 6d. The demand is moderate in South Wales, and supplies seem to be adequate for the works' requirements. Heavy steel scrap in furnace sizes is quiet at 47s. 6d. The Scottish scrap market is quiet and prices are unchanged.

Metals.

Copper.—In the absence of any definite news as to the future of the Exporters' Association, the market continues to be ruled by the fluctuations of the dollar exchange. There has been little business passing in the home market, and consumers will not enter into forward contracts, in view of the present discord amongst the producers, who are unable to agree on the proposals for regulation of sales.

Closing quotations :—

Cash.—Thursday, £37 10s. to £37 12s. 6d.; Friday, £37 10s. to £37 11s. 3d.; Monday, £36 15s. to £36 16s. 3d.; Tuesday, £36 13s. 9d. to £36 15s.

Three Months.—Thursday, £38 2s. 6d. to £38 3s. 9d.; Friday, £38 2s. 6d. to £38 3s. 9d.; Monday, £37 6s. 3d. to £37 7s. 6d.; Tuesday, £37 6s. 3d. to £37 7s. 6d.

Tin.—The market for this metal remains quiet, consumers both in the U.S.A. and in Europe still being in an unsatisfactory position. It is, however, reported that there is an improved tone in the Welsh tinplate industry. Any further change in tin prices will be due to the movements of the sterling exchange.

Official closing prices :—

Cash.—Thursday, £136 15s. to £136 17s. 6d.; Friday, £137 to £137 5s.; Monday, £136 17s. 6d. to £137; Tuesday, £136 7s. 6d. to £136 10s.

Three Months. — Thursday, £139 15s. to £139 17s. 6d.; Friday, £140 to £140 5s.; Monday, £139 17s. 6d. to £140; Tuesday, £139 7s. 6d. to £139 10s.

Spelter.—The demand has shown a slight falling-off, but the market is in strong control, and the recent fall in price was solely due to an improvement in the dollar rate.

Daily fluctuations :—

Ordinary.—Thursday, £14 1s. 3d.; Friday, £14 3s. 9d.; Monday, £14; Tuesday, £14.

Lead.—This metal is considered to be in the best position. The demand is steady, and exchange fluctuations are less disturbing. Buying is fairly good, in view of the heavy sales that occurred at the end of September.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £15; Friday, £14 18s. 9d.; Monday, £14 16s. 3d.; Tuesday, £14 16s. 3d.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The New Preston Section.

To the Editor of The Foundry Trade Journal.

Sir,—The Preston Section of the Lancashire Branch held their opening meeting last night in the Technical College, Preston, at which I was present. It was one of the best meetings I have ever been at. Approximately 75 people were present. The Preston Section has now 69 members and 5 subscribing firms. Well over 50 have paid their subscriptions, which is extraordinarily good.

Mr. Walter West, of Leyland Motors, Limited, gave a general talk on steel, iron and bronze founding, covering these subjects generally. I opened the discussion, congratulating the Preston Section on the large number present and the enthusiasm shown. The following also spoke: Messrs. Jackson, Hogg, Hodgson, T. Green, Meadowcroft, Gibson and several other Preston members whose names I was unable to get.

The Junior Vice-President, Mr. W. Dewhurst, proposed a vote of thanks to Mr. West, and expressed his great delight at the number present, the enthusiasm exhibited and the long-felt want of a Branch in the district of Preston, which had now been accomplished, and they would not rest until they had got 100 members at least and were formed into a Branch of their own and not a Section of Lancashire. This was seconded by one of their members, Mr. Hodgson. I may say three Past-Presidents of the Lancashire Branch were present also.

The Preston Section propose to hold a social evening of some kind in the near future. They exhibited last night great enthusiasm for the formation of a Junior Section. I propose to go over at the next meeting and explain precisely how we run the Junior Section in the Lancashire Branch. For their next meeting it was proposed that every member present should try and bring an apprentice with him with a view to stimulating interest amongst juniors and the formation of a Junior Section.—Yours, etc.,

Roy Stubbs,
Lancashire Branch-President.

36, Broadway,
Cheadle, Cheshire.
December 10, 1931.

Applications for Trade Marks.

The following list of applications to register trade marks is taken from the "Trade Marks Journal."—

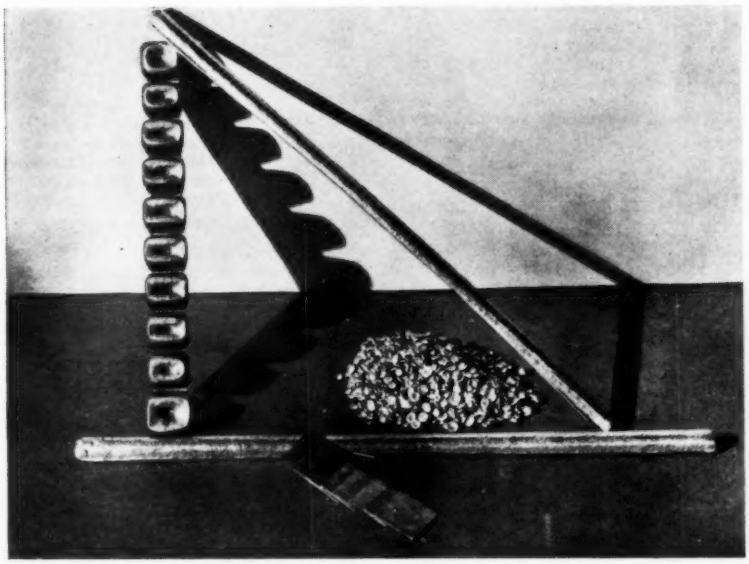
"Alduron."—Metal castings in the rough. William Mills, Limited, Grove Street, Birmingham.

"Cuprador."—Metals. Dorman, Long & Company, Limited, 55, Broadway, London, S.W.1.

"Blake Marsden."—Crushing, mixing, drying, washing, screening and elevating plant; Bessemer converters; quarrying plant and belt conveyors. H. R. Marsden, Limited, Soho Foundry, Meadow Road, Leeds.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

For Effective De-oxidising.



The cause of many wasters in the founding of cast-iron and steel is the presence of oxides in the melt, and the addition of a few ounces (2 to 8) of aluminium to a ton of molten iron is remarkably effective in reducing these oxides, and in so restoring the fluidity of the iron as to render the casting of the thinnest sections a simple matter.

If finely divided aluminium is mixed with tungsten, the latter is prevented from oxidation and is readily dissolved by the iron.

In the casting of steel blooms, the addition of about 0.05 per cent. of aluminium is remarkably effective in preventing the formation of blow-holes in the upper portions of the casting, and so removing one of the most serious difficulties encountered in this work.

For the above purposes, aluminium is supplied in various convenient forms—notched bars, half-round sticks, granulated or granules ('buttons'). Alternatively, the metal is employed in the form of squares of sheet metal about 1½" × 1½"; these are supplied by the British Aluminium Co., Ltd., in two thicknesses, one in which the squares run 128 to the lb. (⅛ oz. each), and in the other 64 to the lb.; the use of these squares saves all trouble of weighing, and the user can add any predetermined percentage of aluminium to his iron or steel with a minimum of delay and inconvenience.

F.T.J. 17-12 31.

Aluminium

THE BRITISH ALUMINIUM CO., LTD.
ALUMINIUM PRODUCERS. ADELAIDE HOUSE.
KING WILLIAM STREET. LONDON. E.C.4.

'Phone: Mansion House 5561 & 8074 (5 lines). Telegrams: Cryolite-Bilgate, London.

"SIROCCOFIN"

A magnified view of the "Siroccofin" Tube, showing the copper fin helically wound round the tube.

GILLED PIPE
AIR HEATERS
for Heating, Ventilating, or Drying Installations.

Efficient Heat Transmission. Economy of Space. Strong in construction and compact. Light in weight. Suitable for pressures up to 200 lbs. per square inch.

Supplied in standard sizes with tubes varying from 2 ft. to 10 ft. in length, which can be built up to form a heating battery of any number of sections.

Write for Catalogue No. 30—

DAVIDSON & CO., LTD.
Sirocco Engineering Works,
BELFAST.
LONDON, MANCHESTER, BIRMINGHAM, NEWCASTLE, BRISTOL, CARDIFF, GLASGOW.

···TRADE··· SIROCCO ···MARK···

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	36	13	9
Three months	37	6	3
Electrolytic	43	0	0
Tough	37	15	0
Best selected	38	0	0
Sheets	75	0	0
India	51	10	0
Wire bars	45	10	0
Do., January	45	10	0
Do., February	45	10	0
Ingot bars	45	10	0
H.C. wire rods	47	0	0
Off. av. cash, Nov.	35	18	1⅛
Do., 3 mths., Nov.	36	9	10 5/16
Do., Sttlmnt., Nov.	35	17	11⅞
Do., Electro, Nov.	42	1	2⅜
Do., B.S., Nov.	38	3	1½
Do., wire bars, Nov.	42	18	6⅜
Solid drawn tubes			11d.
Brazed tubes			11d.
Wire			7½d.

BRASS.

Solid drawn tubes	10d.
Brazed tubes	12d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	7½d.
Yellow metal rods	5½d.
Do. 4 × 4 Squares	6½d.
Do. 4 × 3 Sheets	6½d.

TIN.

	£	s.	d.
Standard cash	136	7	6
Three months	139	7	6
English	138	5	0
Bars	140	10	0
Straits	138	10	0
Australian	138	2	6
Eastern	143	12	6
Banca (nom.)	150	17	6
Off. av. cash, Nov.	132	18	10⅜
Do., 3 mths., Nov.	135	2	6
Do., Sttlmt., Nov.	132	17	10⅜

SPELTER.

	£	s.	d.
Ordinary	14	0	0
Remelted	13	5	0
Hard	11	5	0
Electro 99.9	16	5	0
English	14	15	0
India	13	10	0
Zinc dust	23	0	0
Zinc ashes	4	0	0
Off. aver., Nov.	14	0	10 5/16
Aver. spot, Nov.	13	16	10⅜

LEAD.

	£	s.	d.
Soft foreign ppt.	14	16	3
English	16	5	0
Off. average, Nov.	14	10	8 3/16
Average spot, Nov.	14	11	6½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whf.	27	0	0
Rods	32	0	0
Boiler plates			—
Battery plates			—

ANTIMONY.

	£	s.	d.
Special brand, Eng.	40	0	0
Chinese	29	10	0
Crude	22	0	0

QUICKSILVER.

Quicksilver (nom.) .. 18 17 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	6 17 6
45/50%	9 12 6
75%	14 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free, 4/2, plus 55%, per lb. Mo.	
Ferro-titanium—	
23/25% carbon-free	11½d. lb.
Ferro-phosphorus, 20/25%	£16 17 6
Ferro-tungsten—	
80/85%	1/8½ lb. plus 20%
Tungsten metal powder—	
98/99%	1/11½ lb. plus 20%
Ferro-chrome—	
2/4% car.	£34 10 0
4/6% car.	£24 10 0
6/8% car.	£23 17 6
8/10% car.	£22 2 6
Ferro-chrome—	
Max. 2% car.	£36 5 0
Max. 1% car.	£41 17 6
Max. 0.70% car.	£52 0 0
70%, carbon-free	11½d. lb.
Nickel—99% (nom.)	£245 to £250
Ferro-cobalt	10/3 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	3/- lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £ 9 0 0
Metallic manganese—	
94/96% carbon-free	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy steel				2	7	6
Bundled steel and shrngs.	1	18	6 to	2	6	6
Mixed iron and steel	2	2	0 to	2	3	6
Heavy cast iron	2	7	6 to	2	8	0
Good machinery for foundries	2	12	6 to	2	15	0
Cleveland—						
Heavy steel				2	2	6
Steel turnings				1	12	6
Cast-iron borings				1	6	0
Heavy forge				3	2	6
W.I. piling scrap				2	15	0
Cast-iron scrap	2	5	6 to	2	7	6
Midlands—						
Light cast-iron scrap				2	0	0
Heavy wrought				2	15	0
Steel turnings, f.o.r.				1	2	6
Scotland—						
Heavy steel				2	2	6
Ordinary cast iron				2	8	0
Engineers' turnings				1	10	0
Cast-iron borings				1	12	0
Wrought-iron piling				2	7	6
Heavy machinery				2	17	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	32	0	0
Brass	24	0	0
Lead (less usual draft)	13	0	0
Tea lead	10	0	0
Zinc	7	5	0
New aluminium cuttings	62	0	0
Braziery copper	30	0	0
Gunmetal	28	0	0
Hollow pewter	90	0	0
Shaped black pewter	70	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	65/6
Hematite M/Nos.	65/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	73/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
,, No. 4 forge*	61/-
,, No. 3 fdry.*	66/-
Shrops basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	57/6
,, fdry. No. 3*	62/6
,, fdry. No. 1*	65/6
Derbyshire forge*	61/-
,, fdry. No. 3*	66/-
,, fdry. No. 1*	69/-
,, basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	72/-
,, No. 3	69/6
Hem. M/Nos. d/d	68/6
Sheffield (d/d district)—	
Derby forge	58/6
,, fdry. No. 3	63/6
Lincs forge	—
,, fdry. No. 3	63/6
E.C. hematite	76/-
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
,, fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	87/-
Clyde, No. 3	87/-
Monkland, No. 3	87/-
Summerlee, No. 3	87/-
Eglinton, No. 3	87/-
Gartsherrie, No. 3	87/-
Shotts, No. 3	87/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	15	0 to	10	5	0
Nut and bolt iron	8	7	6 to	8	12	6
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	10	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	17	6 to	9	15	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)		6	17	6 & up.		
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)				9	10	0
Black sheets, 24g.	8	0	0 to	9	0	0
Galv. cor. shts.	9	0	0 to	9	10	0
Galv. flat sheets	9	10	0 to	10	0	0
Galv. fencing wire, 8g. plain				—		
Billets, soft	5	7	6 to	5	12	6
Billets, hard				6	12	6
Sheet bars	5	0	0 to	5	10	0
Tin bars				5	0	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11⅜d.
Sheet to 10 w.g.	12⅜d.
Wire	12⅜d.
Rods	11⅜d.
Tubes	17d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1⅝ to 1/7⅝
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	15.51
No. 2 foundry, Valley	16.00
No. 2 foundry, Birm.	12.00
Basic	16.76
Bessemer	18.26
Malleable	18.26
Grey forge	17.76
Ferro-mang. 80%	85.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.50
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	1.80
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	2.90
Wire nails	1.90
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	22/6
,, furnace	16/- to 17/6
Durham and Northumberland—	
,, foundry	15/- to 15/6
,, furnace	15/-
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	13/6 to 13/9
,,	28×20 ,,	27/- to 27/6
,,	20×10 ,,	20/-
,,	18¾×14 ,,	14/6
C.W.	20×14 ,,	12/6 to 12/9
,,	28×20 ,,	25/3
,,	20×10 ,,	19/4½
,,	18¾×14 ,,	13/9

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars, hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water	58½%	52½%
Steam	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Dec.	10	37	10	0	dec. 10/-
,,	11	37	10	0	No change
,,	14	36	15	0	dec. 15/-
,,	15	36	13	9	,, 1/3

Electrolytic Copper.

		£	s.	d.	
Dec.	10	43	0	0	No change
,,	11	44	0	0	inc. 20/-
,,	14	43	10	0	dec. 10/-
,,	15	43	0	0	,, 10/-

Standard Tin (cash).

		£	s.	d.	
Dec.	10	136	15	0	dec. 10/-
,,	11	137	0	0	inc. 5/-
,,	14	136	17	6	dec. 2/6
,,	15	136	7	6	,, 10/-

Tin (English ingots).

		£	s.	d.	
Dec.	10	138	5	0	dec. 15/-
,,	11	138	10	0	inc. 5/-
,,	14	138	10	0	No change
,,	15	138	5	0	dec. 5/-

Zinc Sheets (English).

		£	s.	d.	
Dec.	10	24	10	0	No change
,,	11	24	10	0	,, ,,
,,	14	24	10	0	,, ,,
,,	15	24	10	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
Dec.	10	14	1	3	dec. 2/6
,,	11	14	3	9	inc. 2/6
,,	14	14	0	0	dec. 3/9
,,	15	14	0	0	No change

Lead (English).

		£	s.	d.	
Dec.	10	16	10	0	dec. 5/-
,,	11	16	10	0	No change
,,	14	16	5	0	dec. 5/-
,,	15	16	5	0	No change

Imports and Exports of Iron Castings in November and the eleven months 1931, compared with November and the eleven months 1930.

	November, 1930.	November, 1931.	Eleven months, 1930.	Eleven months, 1931.	November, 1930.	November, 1931.	Eleven months, 1930.	Eleven months, 1931.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	2,068	1,377	19,713	12,637	20,221	20,884	229,151	167,312
Castings, in the Rough, Iron	90	138	2,140	1,317	1,660	2,494	45,533	26,260
,, ,, ,, Steel	554	600	11,875	5,862	14,333	10,625	285,132	118,899
Hollow-ware, Cast, not Enamelled	2	9	37	76	240	656	3,783	5,337
,, ,, Enamelled	—	2	30	50	54	147	1,812	2,788
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	45	89	1,667	800	1,606	4,962	74,914	38,146
,, British South Africa	251	375	2,356	2,214	9,938	10,892	91,654	79,135
,, ,, India	135	112	1,434	1,219	5,140	4,251	52,413	44,534
,, Australia	1	1	253	68	178	176	14,676	3,508
,, New Zealand	92	24	922	330	5,833	1,069	54,304	20,042
Total (including other countries)	1,606	1,518	16,394	12,750	69,448	69,343	725,563	567,320
PIPES AND FITTINGS—CAST—								
To Argentine Republic	571	242	13,934	4,935	5,751	2,640	138,039	47,898
,, British South Africa	1,224	344	9,812	6,892	13,540	4,976	105,006	80,237
,, ,, India	189	101	2,709	1,583	2,625	1,305	40,757	25,379
,, Straits Settlements and Malay States	1,236	165	10,556	2,557	9,915	2,357	91,351	27,887
,, Ceylon	63	133	1,381	720	778	1,139	14,691	8,425
,, Australia	115	19	748	165	2,160	474	13,914	3,767
Total (including other countries)	9,456	6,241	110,596	65,683	102,526	66,320	1,220,293	740,904
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	292	225	3,691	2,023	9,670	7,934	121,258	71,285
,, Enamelled	61	63	761	510	5,630	5,537	65,565	49,174
CASTINGS, in the rough—								
Iron	274	194	2,169	2,230	5,821	5,941	65,582	55,444
Steel	121	44	1,872	1,064	5,760	1,841	78,453	38,299

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

BRASS Moulder, unemployed, seeks engagement as Working Foundry Foreman; full knowledge of melting and mixing of aluminium, nickel, and all non-ferrous alloys; 23 years' practical experience in motor and engineering trades; Manchester district preferred.—Box 950, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

WANTED, fully-qualified Foreman for motor-cylinder foundry in the Midlands. Must be good organiser and have first-class knowledge of up-to-date methods of production. Only first-class man need apply.—References, experience, and salary required, to Box 962, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Any Member, Associate Member or Associate of the Institute of British Foundrymen who desires his qualifications to be inserted in the column must forward to the General Secretary of the Institute the following information:—(a) Name and address; (b) name of present employer (or last employer if unemployed); (c) brief particulars of qualifications, experience, and type of position required. The name will not be disclosed until the candidate is in communication with a prospective employer. Announcements will be inserted in two successive issues, unless announcers' requirements have been met with in the meantime.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

The Institute of British Foundrymen and the Proprietors of THE FOUNDRY TRADE JOURNAL wish it to be clearly understood that they accept no legal responsibility in connection with this service, for which no charge is made to members of the I.B.F.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester.

EXPERIENCED Chief Metallurgist, B.Sc., Hons., desires position; experience includes metallurgical control of foundries, also steels, forgings, heat-treatment, non-ferrous. (154)

YOUNG Foundryman, served apprenticeship and had sound experience as moulder and sound technical training, requires progressive position. Varied experience, including cupola practice. Associate of Metallurgy. (155)

IRON Moulder desires position as Assistant Foundry Foreman; technical knowledge all branches iron and non-ferrous work; moderate salary accepted. (156)

PROPERTY.

BRISTOL.

TO Engineers, Founders, Manufacturers.—Fine site of nearly three acres on arterial road, with Foundry and Workshops and own Rail Sidings into the premises. Modern Offices, Warehouses and Workrooms. Central Heating. —CHARLES A. TRICKS & SON, Auctioneers, St. Nicholas Street, Bristol.

PROPERTY—*Continued.*

MAGNIFICENT

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of Shops.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

TENDER.

GREAT WESTERN RAILWAY.

THE Directors of this Company are prepared to receive Tenders for the supply of the undermentioned Iron and Steel Goods:—

2.—Helical and Volute Springs.
3.—Tyres and Rolled-Steel Wheel Centres.
4.—Steel Axles and Forgings.
5.—Iron Plates and Bars.
6.—Steel Plates and Sheets.
7.—Steel Bars and Blooms.
8.—Steel Castings (Wheel Centres).
9.— Do. (Miscellaneous).
11.—Chain and Iron for Chain Manufacture.
12.—Tubes and Fittings (Gas, Steam, Electric Conduit, etc.).
13.—Weldless Steel Tubes (Boiler, Steam and H.P. Gas, etc.).
14.—Cast-Iron Socket, etc., Pipes and Iron Castings.
15.—Galvanised Sheets.

Specifications and Forms of Tender (upon which alone Tenders will be received) may be obtained on application to the Stores Superintendent at Swindon.

Tenders, addressed to the undersigned and marked outside "Tender for Iron and Steel," will be received not later than 10 a.m. on Tuesday, January 5, 1932.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. DAVIS,
Secretary.

Paddington Station,
London, W.2.
December 15, 1931.

PUBLICATION.

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. A new edition will be published next January. Secure your advertising space now. Rates on application.—INDUSTRIAL NEWSPAPERS, LTD., 49, Wellington Street, Strand, London, W.C.2. Telephone: Temple Bar 3951 (5 lines).

MACHINERY.

'Phone **98** Staines.

STURTEVANT No. 4 ELECTRIC BLOWER, 220 volts D.C., 10-in. delivery. Sturtevant No. 8 Belt-driven BLOWER, 18-in. delivery.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

THOS. W. WARD, LTD.

No. 9 HERBERT Combination Capstans.
EVER-READY Electric Table Surface Grinders, 14-in. and 20-in. dia. stones.
SCHMALTZ Vertical Planetary-spindle Grinder, w.s. table 39 in. x 15 in.
1920 make 5-ton LOCO. STEAM SHUNTING CRANE (Taylor & Hubbard), 31-ft. 6-in. jib; 4-ft. 8½-in. gauge; spring buffers; 80 lbs. w.p.
1917 make 6-wheel 16-in. x 20-in. LOCOMOTIVE (Yorkshire), copper firebox, steel tubes; 150 lbs. w.p.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued.*

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Station Works, Ecclesfield, Sheffield.

MISCELLANEOUS.

FOUNDRIES, why pay high prices for Type? Sharp White-metal Letters, all styles, supplied at your own price.—Address, 32, Enfield Street, Belfast, N. Ireland.

'Phone: 287 SLOUGH

LADLES—GEARED

12-Ton "Stevenson"
9-Ton "MacNeil"
6-Ton "Thwaites"
4-Ton "Evans"
2-Ton "Evans"

SAND PLANT

3 ft. 6 in. "Evans" Sandmill	£15
"Jackman" SM4 Aerator ...	£12
"Herbert" sand whizzer ...	£32
"Jackman" Rotary Sifter ...	£8

BUY FROM ME AND SAVE MONEY!

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